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(54) **METHOD AND COMPOSITION FOR
ENHANCING MILK PRODUCTION AND
MILK COMPONENT CONCENTRATIONS**

(71) Applicant: **PURINA ANIMAL NUTRITION
LLC**, Shoreview, MN (US)

(72) Inventors: **Paul A. Porter**, Webster Groves, MO
(US); **Cindie M. Luhman**, Webster
Groves, MO (US)

(73) Assignee: **PURINA ANIMAL NUTRITION
LLC**, Shoreview, MN (US)

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(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,876,157 A 3/1959 Selden
3,338,718 A 8/1967 Olson et al.
3,794,732 A 2/1974 Raun
3,857,971 A 12/1974 Abdo et al.
3,928,571 A 12/1975 Raun
3,956,482 A 5/1976 Hahn et al.
3,959,493 A 5/1976 Baalsrud et al.
4,127,676 A 11/1978 Merensalmi
4,181,709 A 1/1980 Dannelly
4,289,784 A 9/1981 Bochis et al.
4,376,790 A 3/1983 Ames
4,704,276 A 11/1987 Kantor
4,735,735 A 4/1988 Borggreffe et al.
4,735,809 A 4/1988 Donovan et al.
4,876,097 A 10/1989 Autant et al.
4,996,067 A 2/1991 Kobayashi et al.
5,021,241 A 6/1991 Yamahira et al.
5,081,146 A 1/1992 Fontenot et al.

5,137,735 A 8/1992 Bignon
5,139,777 A 8/1992 Ott et al.
5,145,695 A 9/1992 Smith et al.
5,190,775 A 3/1993 Klose
5,219,596 A 6/1993 Smith et al.
5,236,718 A 8/1993 Huchette
5,244,669 A 9/1993 Satoh et al.
5,252,561 A 10/1993 Homykiewytsch et al.
5,380,525 A 1/1995 Leedle et al.
5,474,785 A 12/1995 Wright et al.
5,496,571 A 3/1996 Blagdon et al.
5,503,112 A 4/1996 Luhman et al.
5,518,730 A 5/1996 Fuisz
5,529,793 A 6/1996 Garner et al.
5,547,686 A 8/1996 Jenkins
5,560,919 A 10/1996 Morikawa et al.
5,585,134 A 12/1996 Cummings et al.
5,660,852 A 8/1997 McKeown et al.
5,707,617 A 1/1998 Conrad et al.
5,741,506 A 4/1998 Bauchart et al.
5,767,080 A 6/1998 Beck et al.
5,807,594 A 9/1998 King et al.
5,843,498 A 12/1998 Takahashi
5,858,424 A 1/1999 Virkki et al.
5,874,103 A 2/1999 Moore et al.
5,906,842 A 5/1999 Sato et al.
5,958,464 A 9/1999 Register

(Continued)

FOREIGN PATENT DOCUMENTS

CA 600707 5/1960
CA 645019 7/1962
CA 2330091 A1 * 7/2002
EP 0998853 B1 5/2000
FR 2469131 5/1981
GB 838766 6/1960
GB 2159690 11/1985
WO WO 93/21782 11/1993
WO WO 97/33488 A1 9/1997
WO WO 00/078160 12/2000

(Continued)

OTHER PUBLICATIONS

Christensen et al. "Effect of Method of Delivery of Propylene Glycol
on Plasma Metabolites of Feed-Restricted Cattle," *J. of Dairy Sci-*
ence, vol. 80, pp. 563-564 (1997).

(Continued)

Primary Examiner — Robert A Wax

Assistant Examiner — Melissa Mercier

(74) *Attorney, Agent, or Firm* — Dorsey & Whitney LLP;
Bridget M. Hayden, Esq.

(57) **ABSTRACT**

A method of feeding a ruminant that entails providing a feed
that comprises sugar alcohol and at least one additional feed
component, where the feed is free of rumen-protected fatty
acid or comprises less than 10 weight percent rumen-pro-
tected fatty acid, based on the total weight of the feed and
further entails orally supplying the feed to the ruminant dur-
ing a pre-partum period when the ruminant is pregnant, where
the ruminant ingests the feed and sugar alcohol during the
pre-partum period.

22 Claims, 6 Drawing Sheets

(56)

References Cited**U.S. PATENT DOCUMENTS**

6,106,871	A	8/2000	Miller	
6,217,915	B1	4/2001	Luchansky et al.	
6,229,031	B1	5/2001	Strohmaier et al.	
6,306,427	B1	10/2001	Annonier et al.	
6,326,051	B1	12/2001	Nakasugi et al.	
6,440,447	B1	8/2002	Luhman	
6,521,249	B2	2/2003	Block et al.	
6,866,861	B1	3/2005	Luhman	
7,037,518	B2	5/2006	Luhman	
7,371,401	B2	5/2008	Miller	
8,110,214	B2 *	2/2012	Porter et al.	424/438
8,591,937	B2 *	11/2013	Porter et al.	424/438
2002/0127259	A1	9/2002	Orthoefer	
2003/0072788	A1	4/2003	Luhman	
2004/0142065	A1	7/2004	de Rodas et al.	
2005/0142168	A1	6/2005	Porter et al.	
2006/0057274	A1	3/2006	Miller	
2006/0088576	A1	4/2006	Luhman	
2008/0146520	A1	6/2008	Block et al.	
2009/0028995	A1	1/2009	Miller	
2012/0195998	A1	8/2012	Porter et al.	

FOREIGN PATENT DOCUMENTS

WO	WO 01/67879	9/2001
WO	WO 03/037102 A2	5/2003
WO	WO 03/045401 A1	6/2003
WO	WO 03/090696 A2	11/2003

OTHER PUBLICATIONS

Ensminger. *Feeds & Nutrition*, pp. 520, 526, 567 (1978).

Ensminger. "Challenge Feeding," *Animal Science*, pp. 725-726, (1977).

Khalili et. al. "The Effects of Added Glycerol or Unprotected Free Fatty Acids or a Combination of the Two on Silage Intake, Milk Production, Rumen Fermentation and Diet Digestibility in Cows Given Grass Silage Based Diets," *Agricultural Food Science in Finland*; vol. 6; Nos. 5-6; pp. 349-362 (May 1997).

Remond et al. "Effects of Feeding Sorbitol on Milk Yield and Blood Characteristics in Dairy Cows in Early Lactation", or "Effet De L'addition De Sorbitol a La Ration Des Vaches Laitieres En Debut De Lactation Sur Leurs Performances et Sur Quelques Parametres Sanguins"; *Reprod Nutr. Dev.* 26 (1 B); pp. 365-366 (1986).

Makinen et al. "A Polyol Mixture in the Diet of Dairy Cows," *Nutrition Reports International*, vol. 23, No. 6, pp. 1077-1088 (Jun. 1981).
Choung et al. "The Effects of Abomasal Infusions of Casein or Soya-Bean-Protein Isolate on the Milk Production of Dairy Cows in Mid-Lactation," *British Journal of Nutrition*, vol. 69, pp. 103-115 (1993).

Oldick et al. "Abomasal Infusion of Glucose and Fat-Effect on Digestion, Production, and Ovarian and Uterine Functions of Cows," (abstract), *J. Dairy Sci.*, vol. 80, pp. 1315-1328 (Jul. 1997), published at: <http://www.aces.uiuc.edu/~gregm/adsa/jds/abs/97/Jul97/ab1315.html>.

Istasse et al. "The Effects of Abomasal Infusions of Casein or Glucose on Milk Yield and on Some Blood Constituents of Dairy Cows in Early and Late Lactation" (Abstract), *Journal of British Society of Animal Production*, pp. 538-539. (1984).

Oldham et al. "Milk Production in Cows Infused Abomasally with Casein, Glucose or Aspartic and Glutamic Acids Early in Lactation" (Abstract), *Proceedings of the Nutrition Society*, p. 65A, vol. 43 (1984).

Lister et al. "Effects of Intraruminal Administration of Polyol to Sheep," *J. Sci. Food Agric.*, vol. 35, pp. 21-28 (1984).

Sauer et al. "Propylene Glycol and Glycerol As a Feed Additive for Lactating Dairy Cows: An Evaluation of Blood Metabolite Parameters," *Canadian Journal of Animal Science*; vol. 53, pp. 265-271, 1973.

Fisher et al. "Effects of Propylene Glycol or Glycerol Supplementation of the Diet of Dairy Cows on Feed Intake, Milk Yield and Composition, and Incidence of Ketosis," *Canadian Journal of Animal Science*, vol. 53, No. 2; pp. 289-296 (1973).

Boyd et al Effects of the Addition of Direct -Fed Microbials & Glycerol to the Diet—J. of Dairy Sci. 94: pp. 4616-4622, Nov. 3, 2010.

Lundeen in Feedstuffs, Jul. 11, 2005 vol. 77 #28; Supplements Aid Dairy Cows.

* cited by examiner

Fig. 1

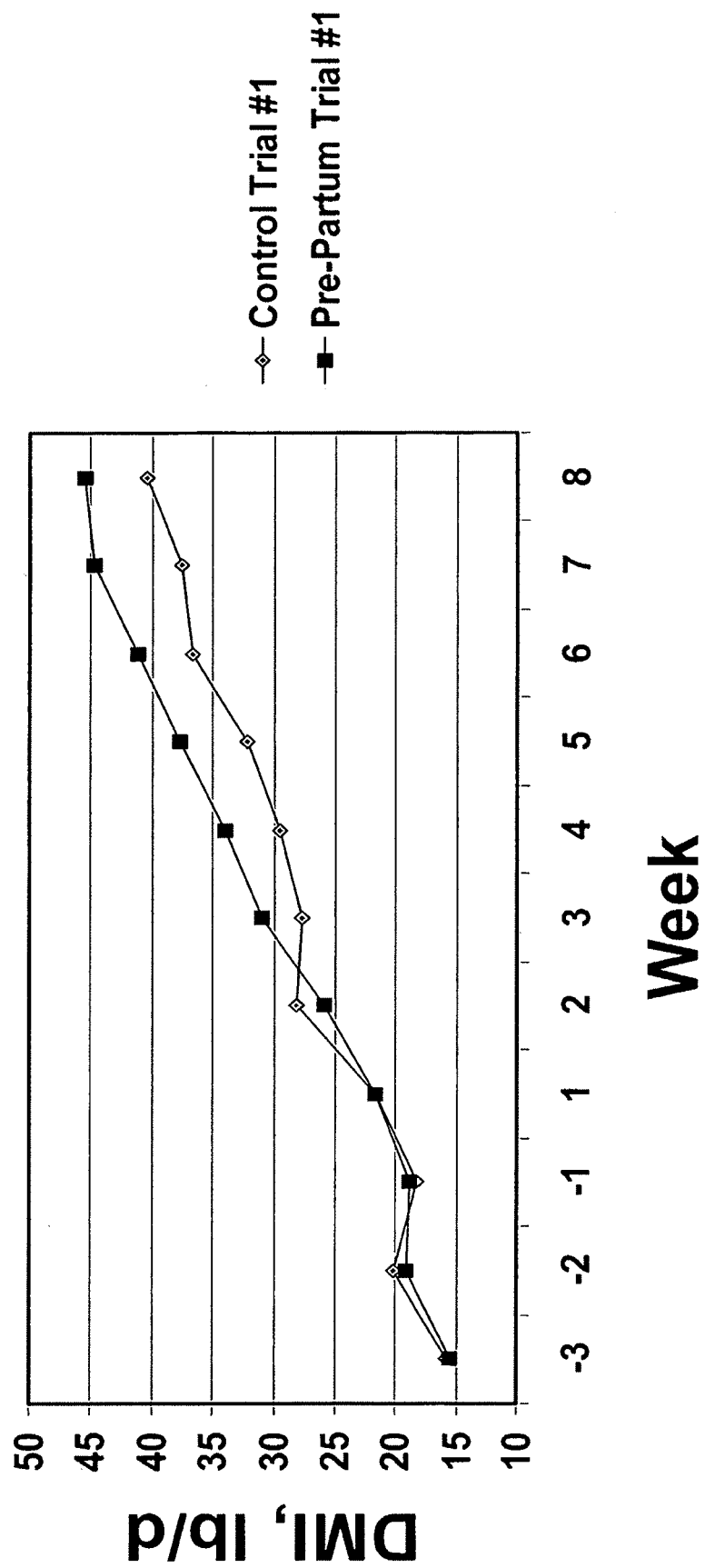


Fig. 2

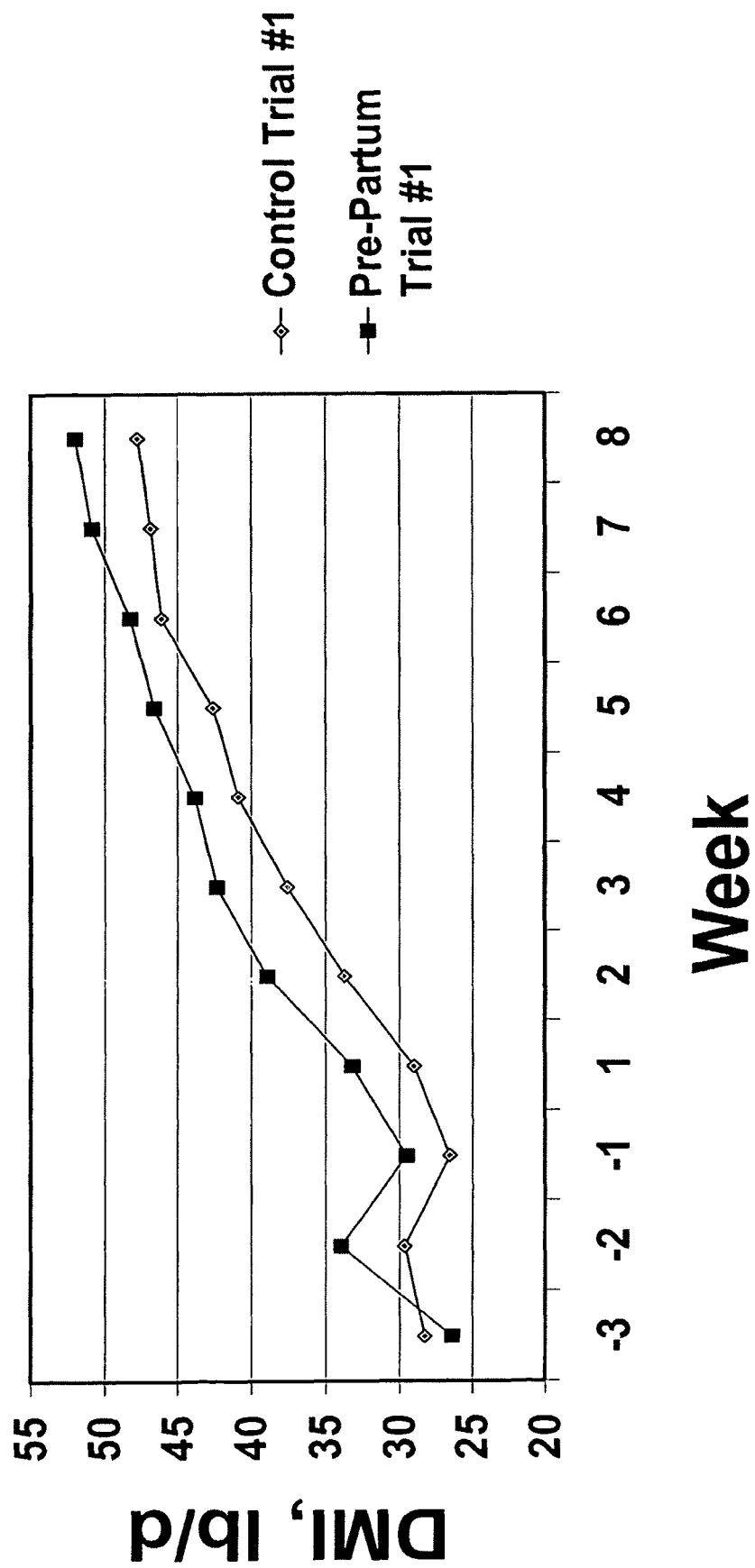


Fig. 3

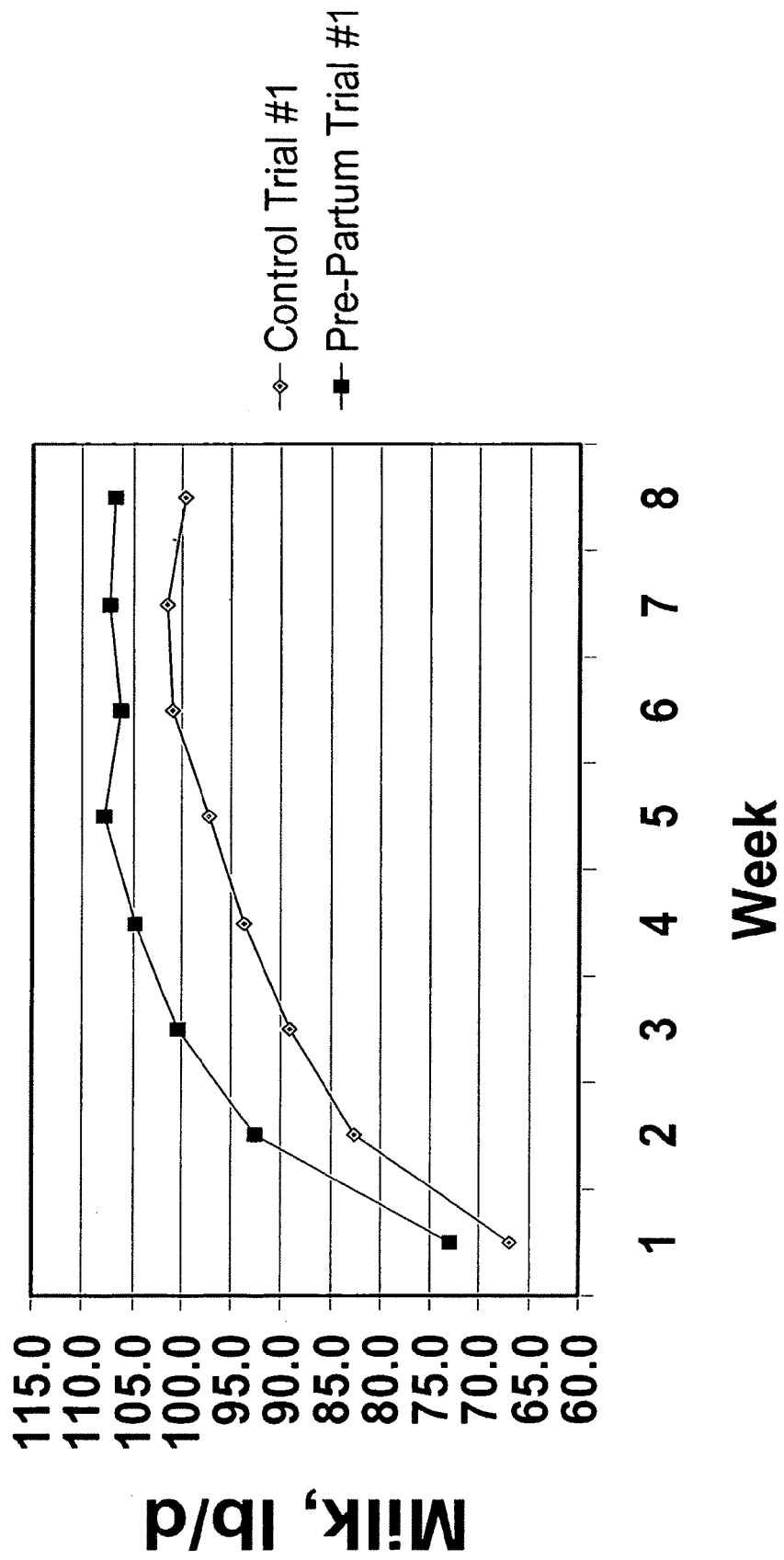


Fig. 4

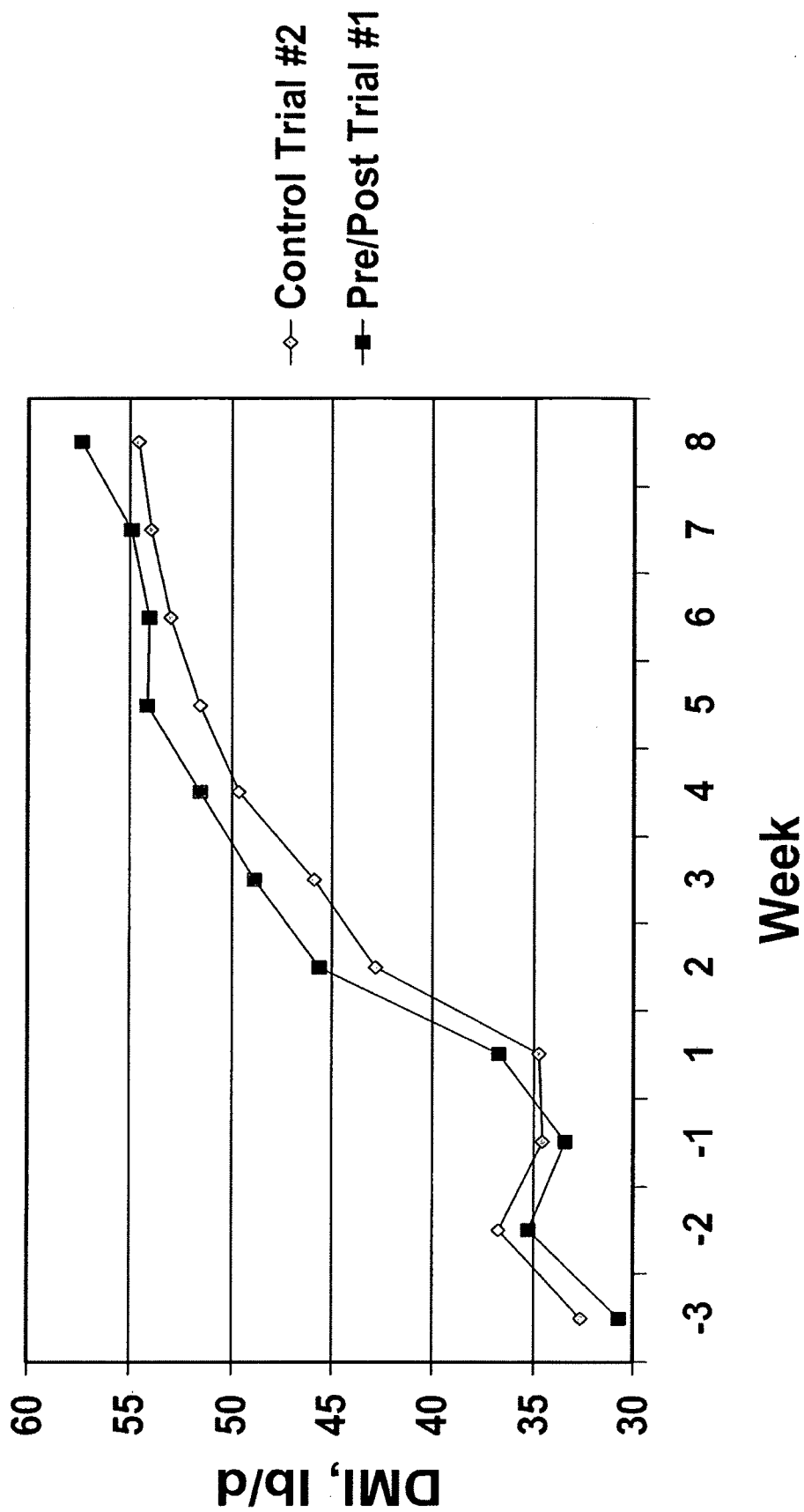


Fig. 5

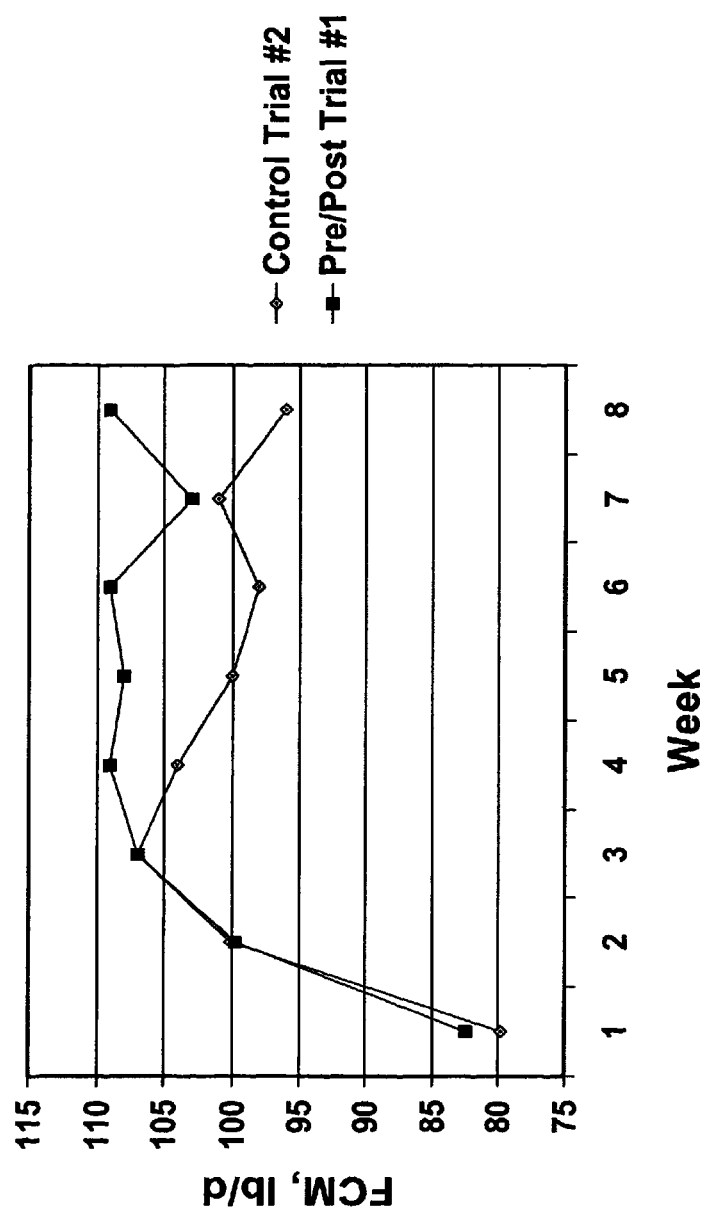
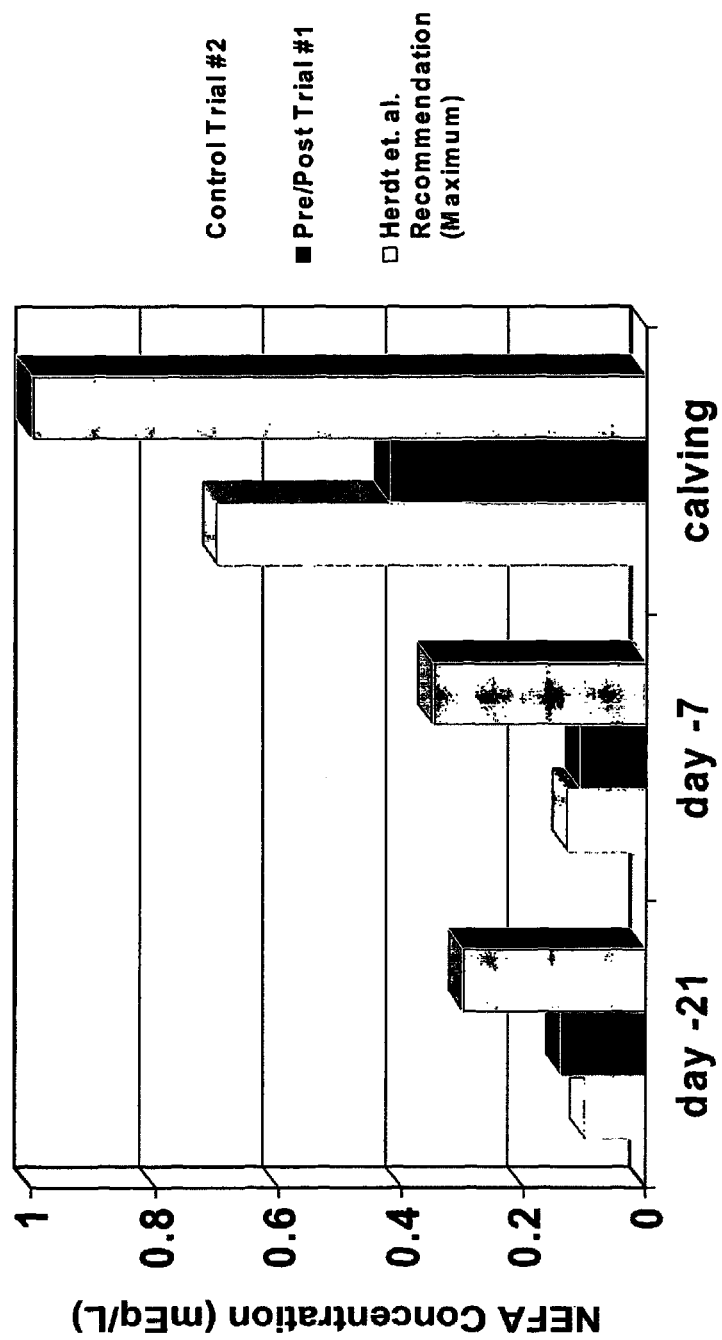


Fig. 6



1

METHOD AND COMPOSITION FOR ENHANCING MILK PRODUCTION AND MILK COMPONENT CONCENTRATIONS

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a continuation of U.S. application Ser. No. 13/363,162, filed Jan. 31, 2012, issued as U.S. Pat. No. 8,591,937 on Nov. 26, 2013, which is a continuation of U.S. application Ser. No. 10/745,286, filed Dec. 23, 2003, issued as U.S. Pat. No. 8,110,214 on Feb. 7, 2012, the entire contents of each are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention generally relates to a method and composition for enhancing fat-corrected milk production and milk component concentrations. More particularly, the present invention relates to a method and composition for enhancing milk production by ruminants and milk component concentrations in milk produced by ruminants.

Milk producers are continually looking for new compositions and methods that permit a selective increase in the amount of milk produced by ruminants. A number of advances have been made over the years in incrementally increasing milk production by ruminants. For example, various changes in the ingredient composition of ruminant feed have been made in attempts to coax ruminants into enhancing feed intake and/or water intake in attempts to increase the amount of milk produced by ruminants.

Additionally, some efforts have focused on modifying the feed composition to cause digestion of particular feed components in particular ruminant stomach components. For example, techniques exist for making certain feed components or feed additives, such as certain proteins, amino acids, and fatty acids rumen-inert. Such rumen-inert feed components or additives are prevented to some extent from being digested in the rumen and consequently are digested to some extent in stomach components other than the rumen, such as in the abomasum. Complicating matters further, care must be taken to assure a particular feeding change does not cause health problems in the ruminant, such as ruminal keratosis, abomasal displacement, or laminitis.

Milk producers are also interested in selectively increasing component concentrations in milk produced by ruminants to incrementally add value to the produced milk. Manufacturers of dairy products value milk having a higher solids content because such milk increases the yield of products made from the milk and components of the milk. Indeed, both in the United States and in many foreign countries, milk producers are paid for the milk on a graded scale based on the amount of fat, protein, or other measures of solids that are contained in the milk.

In this regard, the composition of milk produced by lactating dairy cows may be modified by judicious feeding of certain feed components or additives. For example, promotion of a low acetate:propionate ratio in the volatile fatty acids produced in the rumen of dairy cows is thought to cause a significant decrease in the percentage of milk fat, as well as, a minor increase in the percentage of milk protein in produced milk. This scheme, however, may cause health problems, including ruminal keratosis, displacement of the abomasum, and laminitis, in dairy cows that consume such a ration over extended periods of time. Another effort focused on modifying milk component concentration, specifically milk protein

2

concentration, in ruminant-produced milk relies upon feeding rumen-inert amino acids, especially methionine and lysine.

Though the various ruminant feeding techniques that have been proposed and/or practiced over the years have enhanced the overall knowledge base with respect to ruminant feeding, these techniques have not adequately resolved the issue of how to most economically, efficiently, and effectively increase the amount of milk produced by ruminants and/or increase the concentration of milk components in ruminant-produced milk. Therefore, a need still exists for an improved method and composition for feeding ruminants that enhances the amount of milk produced by the ruminants and/or enhances the concentration of milk components in the ruminant-produced milk.

SUMMARY OF THE INVENTION

The present invention includes various methods of feeding a ruminant. One method entails providing a feed that comprises sugar alcohol and at least one additional feed component, where the feed is free of rumen-protected fatty acid or comprises less than 10 weight percent rumen-protected fatty acid, based on the total weight of the feed. This method further entails orally supplying the feed to the ruminant during a pre-partum period when the ruminant is pregnant, where the ruminant ingests the feed and sugar alcohol during the pre-partum period. The present invention further includes additional methods of feeding a ruminant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph depicting differences in dry matter intake in primiparous cows that are fed a control ration versus primiparous cows that are fed the control ration, along with sugar alcohol during a pre-partum period, in accordance with the present invention.

FIG. 2 is a graph depicting differences in dry matter intake in multiparous cows that are fed the control ration versus multiparous cows that are fed the control ration, along with sugar alcohol during a pre-partum period, in accordance with the present invention.

FIG. 3 is a graph depicting differences in the amount of milk production by multiparous cows fed the control ration versus multiparous cows fed the control ration, along with sugar alcohol during the pre-partum period, in accordance with the present invention.

FIG. 4 is a graph depicting differences in dry matter intake in multiparous cows that are fed the control ration versus multiparous cows that are fed the control ration, along with sugar alcohol during both a pre-partum period and an early post-partum period, in accordance with the present invention.

FIG. 5 is a graph depicting differences in the weight of 4% fat-corrected milk production by multiparous cows that are fed the control ration versus multiparous cows that are fed the control ration, along with sugar alcohol during both a pre-partum period and an early post-partum period, in accordance with the present invention.

FIG. 6 is a graph depicting differences in the non-esterified fatty acid (NEFA) concentration in blood, at various times, in multiparous cows that are fed the control ration versus multiparous cows that are fed the control ration, along with sugar alcohol during at least a pre-partum period, in accordance with the present invention.

DETAILED DESCRIPTION

The present invention generally relates to a method and composition for enhancing fat-corrected milk production and

milk component concentrations. More particularly, the present invention relates to a method and composition for enhancing fat-corrected milk production by ruminants and milk component concentrations in milk produced by ruminants. The methods and compositions each incorporate sugar alcohol.

It has been discovered that orally feeding sugar alcohol(s) to a female ruminant surprisingly causes subsequent increases in both the amount of fat-corrected milk produced by the female ruminant and increased milk component concentrations in the produced milk. Furthermore, the sugar alcohol feeding method of the invention enhances post-partum feed intake, on a dry matter basis. The sugar alcohol component of the feed, when initially provided prior to the onset of lactation, apparently improves the energy balance of the female ruminant. This improved energy balance apparently contributes to the increased fat-corrected milk production, the increased milk component concentrations in the produced milk, and the increased feed intake. This result is surprising since it has traditionally been thought that orally ingested sugar alcohol that is not ruminally-protected would be substantially, if not predominantly, digested in the rumen of the ruminants and would consequently cause negligible, if any, increases in ruminant milk production and milk component concentrations. Furthermore, in the course of formulating the feed of the present invention, no particular efforts are taken to create a feed composition that minimizes the residence time, and consequently digestion, of the sugar alcohol(s) in the rumen.

As used herein, the term "ruminant" means an even-toed hoofed animal that has a complex 3- or 4-chamber stomach and typically rechews previously swallowed feed matter. Some non-exhaustive examples of ruminants include cattle, sheep, goats, oxen, musk ox, llamas, alpacas, guanicos, deer, bison, antelopes, camels, and giraffes. The digestive tract of a cow, one example of the female ruminant that may be fed in accordance with the present invention, includes a stomach with four relatively distinct sections: a rumen, a reticulum, an omasum, and an abomasum. The four sections of the stomach may affect digestion of a component passing through the stomach because each section of the stomach serves a different function in the digestive process. In the rumen, food is mixed with saliva and then churned in a coordinated motion. The food mixture undergoes some fermentation and bacterial digestion in the rumen. The mixture of food and saliva then passes to the reticulum where the mixture is formed into a cud the cow may regurgitate and further chew. After thoroughly chewing the regurgitated cud, the cow re-swallows the cud which then passes into the rumen, through the reticulum, and into the omasum, if particle size restrictions are satisfied. While in the omasum, the mixture is additionally mixed to maintain the mixture in a homogenous state and to remove excess fluid. Then, the homogenous mixture is passed from the omasum to the abomasum, where gastric digestion occurs.

The feed composition administered in accordance with the present invention includes, or is orally fed to the ruminants along with, at least one sugar alcohol. As used herein, the term "sugar alcohol" is defined as a polyhydric alcohol (also known as a polyol) formed by the reduction of the carbonyl group of a sugar to a hydroxyl group, with no more than one hydroxy group being attached to any one carbon atom of the sugar alcohol. Sugar alcohol(s) included as part of the feed composition or added to the feed composition in accordance with the present invention may generally take any form(s). For example, the sugar alcohol(s) may be in crystalline form, in syrup form, an aqueous mixture of water and crystalline

sugar alcohol(s), an aqueous mixture of water and sugar alcohol syrup, or in any combination of any of these different forms.

One exemplary sugar alcohol that may be used in practicing the present invention is sorbitol. Some other examples of sugar alcohols that may be used in practicing the present invention include adonitol; allitol; altritol (D-altritol, L-altritol, and D, L altritol); arabinitol (D-arabinitol, L-arabinitol, and D, L arabinitol); dulcitol (a.k.a galactitol); erythritol; galaxitol; glucitol (D-glucitol, L-glucitol, and D, L glucitol); glycerol; iditol (D-iditol and L-iditol); inositol; isomalt; lactitol; maltitol; mannitol (D-mannitol, L-mannitol, and D, L mannitol); perseitol; ribitol; rhamnitol; threitol (D-threitol, L-threitol, and D, L threitol); and xylitol. The sugar alcohols listed in this paragraph, in any combination and in any proportion, may be provided as part of, or along with, the feed composition. Though any mixture of the described sugar alcohols may be employed, any particular one of the described sugar alcohols may likewise be individually included in, or along with, any particular batch of the feed composition that is orally fed to the ruminants. As one non-exhaustive example, the sugar alcohol may include any, some, or all of the listed sugar alcohols in any combination or proportion. Also, the sugar alcohol(s) employed as part of, or along with, the feed composition, may exclude or be free of any of the listed alcohols, such as glycerol, for example.

The sugar alcohol(s) employed as part of the feed composition or that is added to the feed composition in accordance with the present invention need not be rendered rumen-inert or rumen-protected. Instead, beneficial aspects of the present invention are generally realized when sugar alcohol(s) that are fully digestible in the rumen of the ruminant are included as part of the feed composition, or are added to the feed composition, that is orally fed to the ruminants. Furthermore, in the course of formulating the feed of the present invention, no particular efforts need be taken to create the feed composition in a form that minimizes the residence time, and consequently digestion, of the sugar alcohol(s) in the rumen.

The feed composition and associated sugar alcohol(s) may be fed to female ruminants in accordance with the present invention (1) when the female ruminants are pregnant and are producing milk (i.e., are lactating), (2) when the female ruminants are pregnant and are not (or no longer are) lactating, and/or (3) after the female ruminants have given birth, are lactating and producing milk, but are not pregnant. Female ruminants that were previously lactating but are not presently lactating are commonly referred to in the dairy industry as being in a dry period. Pregnant female ruminants that were formerly lactating while pregnant typically have a dry period that extends from about two months before giving birth up until about the time of giving birth, though the dry period of a pregnant ruminant may sometimes start earlier than about two months before giving birth and may sometimes start later than about two months before giving birth. Pregnant female ruminants that were formerly lactating while pregnant, but are now in the dry period, are sometimes referred to as late-term pregnant ruminants.

For each individual pregnant ruminant (i.e., a "pre-partum ruminant"), the period when the feed composition and associated sugar alcohol(s) is provided to the pregnant ruminant prior to the pregnant ruminant giving birth is referred to herein as a pre-partum period, and may also be referred to as a pre-parturient period. For each individual female ruminant that has recently given birth (i.e., a "post-partum ruminant"), the period when the feed composition and associated sugar alcohol(s) is provided to the female ruminant soon after the

5

female ruminant has given birth is referred to herein as an early post-partum period, and may also be referred to as an early post-parturient period.

The pre-partum period may generally be of any duration during the pregnancy of the pregnant ruminant and may start and end anytime during the pregnancy of the pregnant ruminant. Generally, however, the feed composition and associated sugar alcohol(s) are provided to the pregnant ruminant in accordance with the present invention during a pre-partum period that starts several weeks, such as about three to about four weeks, before the pregnant ruminant gives birth and ends shortly before, or even on the day the pregnant ruminant gives birth. Beneficially, the pre-partum period when the feed composition and associated sugar alcohol(s) are fed to female ruminants in accordance with the present invention begins at or after the onset of any dry period of pregnant ruminants, and particularly multiparous pregnant ruminants. Nonetheless, the feed composition and associated sugar alcohol(s) may be provided to the pregnant ruminant starting anytime during the pregnancy of the pregnant ruminant, such as about eight weeks, about seven weeks, about six weeks, about five weeks, about four weeks, about three weeks, about two weeks, or even only about one week before the pregnant ruminant gives birth.

Likewise, provision of the feed composition and associated sugar alcohol(s) to the pregnant ruminant may be ended anytime during the pregnancy of the pregnant ruminant, such as about four weeks, about three weeks, about two weeks, or about one week before the pregnant ruminant gives birth or even on the day the pregnant ruminant gives birth. In one embodiment, the feed composition and associated sugar alcohol(s) are provided to the pregnant ruminant during the pre-partum period that has a duration of about two weeks to about four weeks and ends at about the time the pregnant ruminant gives birth to improve feed intake (dry matter basis) by the female ruminant at the time the female ruminant gives birth and shortly after the female ruminant gives birth. Beneficially, provision of the feed composition and associated sugar alcohol(s) to the pregnant ruminant during the pre-partum period that has a duration of about two weeks to about four weeks and ends at about the time the pregnant ruminant gives birth may improve the energy balance of the female ruminant at the time the female ruminant gives birth and shortly after the female ruminant gives birth.

The early post-partum period may generally be of any duration after the female ruminant gives birth and may generally start anytime after the female ruminant gives birth and end anytime after the female ruminant gives birth. Generally, however, the feed composition and associated sugar alcohol(s) are provided to the female ruminant in accordance with the present invention during the early post-partum period that starts on the day the female ruminant gives birth or anytime during the first week after the female ruminant gives birth. Nonetheless, the feed composition and associated sugar alcohol(s) may be provided to the female ruminant starting anytime after the female ruminant gives birth, such as about one week, about two weeks, or even as long as about three weeks after the female ruminant gives birth.

Likewise, provision of the feed composition and associated sugar alcohol(s) to the female ruminant may be ended anytime after such early post-partum provision of the feed composition and associated sugar alcohol(s) to the female ruminant has been started, such as about one week, about two weeks, about three weeks, or about four weeks after the female ruminant gives birth. In one embodiment, the feed composition and associated sugar alcohol(s) are provided to the female ruminant during the early post-partum period that

6

has a duration of about two weeks to about four weeks and starts at about the time the female ruminant gives birth to improve the energy balance of the female ruminant during the period immediately following when the female ruminant gives birth.

The feed composition and associated sugar alcohol(s) may be provided to the female ruminant both during the pre-partum period and during the early post-partum period to enhance benefits observed when practicing the present invention. As one example, the feed composition and associated sugar alcohol(s) may be provided to the female ruminant during a transition period starting about three to four weeks before the female ruminant gives birth through about the third or fourth week after the female ruminant gives birth. This six to eight week period that encompasses the pre-partum period of about three to four weeks duration ending with the birth coupled with the first three to four weeks following the birth during the early post-partum period is commonly referred to as the "transition period" of the cows in the cattle industry. Furthermore, cows that are traversing this six to eight week transition period are commonly referred to as transition cows.

Nevertheless, it is permissible to provide the feed composition and associated sugar alcohol(s) to the female ruminant only during the pre-partum period or only during the early post-partum period, since benefits of the inventive feeding protocol and formulation are observed when the feed composition and associated sugar alcohol(s) are orally provided to the female ruminant only during the pre-partum period or only during the early post-partum period. The feed composition and associated sugar alcohol(s) provided to the female ruminant during the pre-partum period may be different from the feed composition and associated sugar alcohol(s) provided to the female ruminant during the early post-partum period to adjust for differing energy balance compensations and nutritional needs of the female ruminant during these two different periods. Additionally, the sugar alcohol(s) may be orally provided to the female ruminant at a different rate during the pre-partum period, as compared to the early post-partum period, and vice versa, as desired.

Furthermore, the feed composition and associated sugar alcohol(s) provided to the female ruminant may permissibly vary during different portions of the pre-partum period to adjust for differing energy balance compensations and nutritional needs of the female ruminant during these different portions of the pre-partum period. Additionally, the rate at which the sugar alcohol(s) are orally provided to the female ruminant may permissibly vary during different portions of the pre-partum period to adjust for differing energy balance compensations and nutritional needs of the female ruminant during these different portions of the pre-partum period.

Similarly, the feed composition and associated sugar alcohol(s) provided to the female ruminant may permissibly vary during different portions of the early post-partum period to adjust for differing energy balance compensations and nutritional needs of the female ruminant during these different portions of the early post-partum period. Also, the rate at which the sugar alcohol(s) are orally provided to the female ruminant may permissibly vary during different portions of the early post-partum period to adjust for differing energy balance compensations and nutritional needs of the female ruminant during these different portions of the early post-partum period.

Generally, the feed composition that is orally fed to the ruminant may include any conventional ruminant feed component that is capable of being blended with the sugar alcohol(s) as part of the feed composition or that is capable of being combined with the feed composition of the present

invention, so long as the feed components do not hinder ruminal, abomasal, or intestinal function and are not otherwise harmful to the ruminant. As noted above, in the course of formulating the feed of the present invention, no particular efforts need be taken to create the feed composition in a form that minimizes the residence time, and consequently digestion, of the sugar alcohol(s) in the rumen.

The sugar alcohol may be included as part of the feed composition, such as by including the sugar alcohol, in dry or syrup form, for example, in a feed concentrate that is incorporated in the feed composition. Alternatively, the sugar alcohol may be added to the feed composition as a post-treatment, after the feed composition has been placed in the feed trough of the ruminants that are being fed in accordance with the present invention. After top dressing the sugar alcohol onto the feed composition, it has been found beneficial to periodically stir the feed composition in front of the ruminants being fed. This stirring tends to draw the attention of the ruminants to the feed composition and thereby tends to cause the ruminants to eat some additional amount of the feed composition that includes or has been top dressed with sugar alcohol in accordance with the present invention.

Some non-exhaustive examples of feed components that may be included as part of the feed composition of the present invention include water, forage, beans (e.g., whole, cracked, or ground) or hulls thereof, grains (e.g., whole, cracked, or ground), oils made from beans or grain (e.g., oils based upon or derived from beans or grain, such as corn oil or soybean oil), meal or flour made from beans or grain (e.g., meal or flours oils based upon or derived from beans or grain, such as corn meal or soy flour, including high protein soy meal), syrups made from beans or grain (e.g., syrups based upon or derived from beans or grain, such as corn syrup), fatty acids, commercially available formula feeds, feed concentrates, and mixtures thereof.

Forages encompass hay, haylage, and silage. Some non-exhaustive examples of suitable hays include grass hays (e.g., sudangrass or orchardgrass), alfalfa hay, and clover hay. Some non-exhaustive examples of suitable haylages include grass haylages, such as haylage based on sudangrass or orchardgrass; sorghum haylage; and alfalfa haylage. One non-exhaustive example of suitable silages include corn silage. Some non-exhaustive examples of suitable beans and grains include corn, soybeans, and milo.

Feed concentrates are formulations prepared to include concentrated nutrients, such as protein for muscle promotion, fat and other carbohydrates that are readily convertible into energy, vitamins, and minerals. Some examples of components often included in feed concentrates are soybean hulls, sugar beet pulp, molasses, high protein soybean meal, ground corn, shelled corn, wheat midds, distillers grain, cottonseed hulls, rumen-bypass protein (also known as "rumen-inert protein" and as "rumen-protected protein"), rumen-bypass fat (also known as "rumen-inert fat" and as "rumen-protected fat"), and grease, such as choice white grease. One example of a suitable rumen-bypass protein is SUREPRO® rumen bypass protein that is available from Land O'Lakes Farmland Feed LLC of Arden Hills, Minn. One example of a suitable rumen-bypass fat is MEGALAC® rumen bypass fat that is available from Church & Dwight Co. of Princeton, N.J. Some examples of suitable formula feeds include Peak Plus® 37 formula feed, Fresh Tran Plus® formula feed, and Condition Plus® formula feed that are each available from Land O'Lakes Farmland Feed LLC and QLF® 4-19 formula feed that is available from Quality Liquid Feeds, Inc. of Dodgeville, Wis.

As used herein, the terms "rumen-bypass," rumen-inert," and rumen-protected," when used to characterize a substance, such as fat, protein, carbohydrate, etc., means the substance is naturally-resistant, to some degree, to alternation during passage of the rumen-bypass substance through the rumen of a ruminant and/or means the substance has been processed, treated, or associated with another material in some fashion that protects, to some degree, the rumen-bypass substance from alternation during passage of the rumen-bypass substance through the rumen of a ruminant.

The feed composition of the present invention may be free of rumen-protected fatty acid or may include rumen-protected free fatty acid. If rumen-protected fatty acid is included in the feed composition, the feed composition will typically contain less than ten weight percent rumen-protected fatty acid, based on the total weight of the feed composition. In many embodiments, if the rumen-protected fatty acid is included in the feed composition, the feed composition may generally contain about five weight percent or less rumen-protected fatty acid, based on the total weight of the feed composition.

The term "silage," as used herein, is defined to mean vegetable matter, other than grass or hay, that has been converted within a silo into a feed for livestock through any of various anaerobic acid fermentation processes. A wide variety of vegetable matter, such as corn, beans, peas, alfalfa, and the like, may be converted within silos into silage. Vegetable matter that is converted into silage is typically harvested while still relatively tender, soft, and relatively high in moisture content and is frequently chopped prior to placement in the silo for conversion to silage. As used herein, the term "silo" encompasses any and all types of structures used to produce silage (e.g., vertical silos, trench silos, silage bags, HARVESTORE® structures, and the like).

The term "haylage," as used herein, is defined to mean hay or grass that has been converted within a silo into a feed for livestock through any of various anaerobic acid fermentation processes. Haylage is somewhat similar to silage, but instead of being based on non-hay/non-grass vegetable matter, is instead based on hay or grass. The hay or grass that is converted into haylage is typically harvested while still relatively green, tender, soft, and high in moisture content and is frequently chopped into particles prior to placement in the silo for conversion to haylage.

Some exemplary components and component concentration ranges for the feed composition provided to female ruminants during the pre-partum period are detailed in Table 1 below.

TABLE 1

Component	Weight Percent (Dry Basis)*
Corn Silage (38% DM)	0 to about 40
Feed Concentrate	about 25 to about 45
Grass Hay	about 10 to about 30
Alfalfa Hay	0 to about 40
Alfalfa Haylage	0 to about 40

*Based on Total Dry Matter Weight of the Feed Composition Provided During The Pre-Partum Period

Some exemplary components and component concentration ranges for feed concentrates incorporated in the feed composition provided to female ruminants during the pre-partum period are detailed in Table 2 below.

TABLE 2

Component	Weight Percent (Dry Basis)*
Soybean Hulls	0 to about 25
Sugar Beet Pulp	0 to about 25
Soybean Meal (48 wt % true protein)	0 to about 25
Ground Corn & Shelled Corn	0 to about 25
Wheat Midds	0 to about 25
Cottonseed Hulls	0 to about 15
LOL SurePro® rumen bypass protein	0 to about 10
Vitamins & Minerals	about 2 to about 5

*Based on Total Dry Matter Weight of the Feed Composition Provided During The Pre-Partum Period

One commercially available feed concentrate that includes all of the components listed in Table 2 at concentrations falling within the concentration ranges detailed in Table 2 is TRANSCOW® Complete 20 Pre-Fresh ration available from Land O'Lakes Farmland Feed, LLC.

Any dosage of sugar alcohol(s) may be ingested by female ruminants during the pre-partum period in accordance with the present invention. The sugar alcohol(s) ingested by the female ruminant(s) during the pre-partum period preferably includes an amount of sugar alcohol(s) that is effective (i.e. an effective amount) to increase one or more of the following variables A, B, C, D, E, F, and/or G and/or decrease the following variable H:

- A. the quantity (weight) of milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth;
 - B. the quantity (weight) of 4 weight % fat-corrected milk (based on the total weight of the milk) produced during the entire interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth;
 - C. the concentration of total fat in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth;
 - D. the concentration of true protein in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth;
 - E. the concentration of lactose in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth;
 - F. the concentration of total solids in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth;
 - G. feed composition intake (dry weight basis) during the interval, or any portion of the interval, when the female ruminant(s) subsequently produce(s) milk while lactating after giving birth; and/or
 - H. the concentration of non-esterified fatty acid (NEFA) in the blood of the female ruminant(s) at the time the female ruminant(s) give(s) birth, anytime during the pre-partum period, or anytime after the female ruminant(s) give(s) birth and subsequently produce(s) milk;
- as compared to the value of the variable(s) A, B, C, D, E, F, G, and/or H exhibited by any comparative female ruminant(s) that does not ingest any sugar alcohol(s) during the pre-partum period.

The sugar alcohol(s) ingested by the female ruminant(s) during the pre-partum period in accordance with the present invention preferably includes an amount of sugar alcohol(s)

that is effective, over an eight week period starting on the day of calving or over any portion of this eight week period, to:

- increase the dry matter feed intake of the female ruminant(s) by at least about five percent, and desirably by at least about eight percent;
- increase the rate of milk production by the female ruminant(s) by at least about five percent, and desirably by at least about eight percent;
- increase the rate of 4% fat-corrected milk production by the female ruminant(s) by at least about five percent, and desirably by at least about ten percent;
- increase the concentration of true protein in milk produced by the female ruminant(s) by at least about two percent, and desirably by at least about four percent;
- increase the concentration of fat in milk produced by the female ruminant(s) by at least about five percent, and desirably by at least about ten percent;
- increase the concentration of lactose in milk produced by the female ruminant(s) by at least about one percent, and desirably by at least about three percent;
- increase the concentration of total solids in milk produced by the female ruminant(s) by at least about one percent, and desirably by at least about three percent;
- decrease the NEFA concentration in the blood of the female ruminant(s) by at least about ten percent, and desirably by at least about twenty percent, anytime during the pre-partum period or anytime after the pre-partum ruminant(s) give(s) birth and subsequently produce(s) milk; and/or
- decrease the NEFA concentration in the blood of the female ruminant(s) by at least about thirty percent, and desirably by at least about forty percent, anytime within the period extending from about one to about two days before the female ruminant(s) give(s) birth to about one to about two days after the female ruminant(s) give(s) birth;

as compared to any pre-partum ruminant(s) that does not ingest any sugar alcohol(s) during the pre-partum period.

Some non-exhaustive examples of suitable daily sugar alcohol ingestion rates by female ruminant(s) during the pre-partum period that are believed effective to increase one or more of the variable(s) A, B, C, D, E, F, and/or G and/or decrease the variable H associated with the female ruminant(s), as compared to the value of the variable(s) A, B, C, D, E, F, G, and/or H exhibited by any comparative female ruminant(s) that does (do) not ingest any sugar alcohol(s) during the pre-partum period, are ingestion rates ranging from about five grams per day per ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols and more typically from about fifty grams per day per female ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period or portion of the pre-partum period. Also, as another alternative approach, the more typical ingestion rate during the pre-partum period ranging from about fifty grams per day per female ruminant to about two hundred grams per day per

11

female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols may permissibly be an ingestion rate over the pre-partum period or any portion of the pre-partum period that ranges from an average of about fifty grams per day per female ruminant to an average of about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period or portion of the pre-partum period.

Two non-exhaustive, though exemplary, daily sugar alcohol ingestion rates by female ruminant(s) during the pre-partum period within the range presented immediately above that are effective to increase one or more of the variable(s) A, B, C, D, E, F, and/or G and/or decrease the variable H associated with the female ruminant(s), as compared to the value of the variable(s) A, B, C, D, E, F, G, and/or H exhibited by any comparative female ruminant(s) that does not ingest any sugar alcohol(s) during the pre-partum period, are (1) a daily sugar alcohol ingestion rate of about seventy-five grams to about one hundred grams of any individual sugar alcohol or any mixture of any sugar alcohols per female ruminant per day and (2) a daily sugar alcohol ingestion rate of about one hundred fifty to about one hundred eighty grams of any individual sugar alcohol or any mixture of any sugar alcohols per female ruminant per day.

As an alternative approach to the daily sugar alcohol ingestion rate ranging from about seventy-five grams to about one hundred grams of sugar alcohol(s) per female ruminant during the pre-partum period, the sugar alcohol ingestion rate may permissibly be an ingestion rate the pre-partum period or any portion of the pre-partum period that ranges from an average of about seventy-five grams per day per female ruminant to an average of about one hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period or portion of the pre-partum period. Likewise, as an alternative approach to the daily sugar alcohol ingestion rate ranging from about one hundred fifty grams to about one hundred eighty grams of sugar alcohol(s) per female ruminant, the sugar alcohol ingestion rate may permissibly be an ingestion rate over the pre-partum period or any portion of the pre-partum period that ranges from an average of about one hundred fifty grams per day per female ruminant to an average of about one hundred eighty grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period or any portion of the pre-partum period.

Some exemplary components and component concentration ranges for the feed composition provided to female ruminants during the early post-partum period are detailed in Table 3 below.

TABLE 3

Component	Weight Percent (Dry Basis)*
Corn Silage (32% DM)	0 to about 45
Haylage (31% DM)	0 to about 45
Alfalfa Hay (160 FRV)	0 to about 45
Grass Hay	0 to about 15
Concentrate	about 30 to about 70

*Based on Total Dry Matter Weight of the Feed Composition Provided During The Early Post-Partum Period

Some exemplary components and component concentration ranges for feed concentrates incorporated in the feed composition provided to female ruminants during the early post-partum period are detailed in Table 4 below.

12

TABLE 4

Component	Weight Percent (Dry Basis)*
5 Soybean Hulls	0 to about 20
Molasses	0 to about 3
Soybean Meal (48 wt % true protein)	0 to about 20
Ground Corn & Shelled Corn	about 10 to about 25
Distiller Grain	0 to about 15
Wheat Midds	0 to about 20
10 Whole Cottonseed	0 to about 15
LOL SUREPRO® Rumen Bypass Protein	about 1 to about 10
MEGALAC® Rumen Bypass Fat	0 to about 3
Choice White Grease	0 to about 2
Vitamins & Minerals	about 2 to about 10

15 *Based on Total Dry Matter Weight of the Feed Composition Provided During The Early Post-Partum Period

Any dosage of sugar alcohol(s) may be ingested by female ruminants during the early post-partum period in accordance with the present invention. The combination of the sugar alcohol(s) ingested by the ruminant(s) during the pre-partum period and the sugar alcohol(s) ingested by the ruminant(s) during the subsequent early post-partum period preferably includes amounts of sugar alcohol(s) that are effective (i.e. an effective amount) to increase one or more of the following

25 variables I, J, K, L, M, N, and/or O:

- I. the quantity (weight) of milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period;
- 30 J. the quantity (weight) of 4 weight % fat-corrected milk (based on the total weight of the milk) produced during the entire interval, or any portion of the interval, when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period;
- 35 K. the concentration of total fat in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period;
- 40 L. the concentration of true protein in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period;
- 45 M. the concentration of lactose in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period;
- 50 N. the concentration of total solids in milk produced during the entire interval, or any portion of the interval, when the female ruminant(s) when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period; and/or
- 55 O. feed composition intake (dry weight basis) during the interval, or any portion of the interval, when the female ruminant(s) when the female ruminant(s) produce(s) milk while lactating during or following the early post-partum period;

60 as compared to the value of the variable(s) I, J, K, L, M, N, and/or O exhibited by any comparative female ruminant(s) that do not ingest any sugar alcohol(s) during the pre-partum period and/or do not ingest any sugar alcohol(s) during the subsequent early post-partum period.

65 The sugar alcohol(s) ingested by the female ruminant(s) during the early post-partum period and during the pre-partum period in accordance with the present invention prefer-

13

ably includes an amount of sugar alcohol(s) that is effective, over an eight week period starting on the day of calving or over any portion of this eight week period, to:

- increase the dry matter feed intake of the female ruminant(s) by at least about five percent, and desirably by at least about eight percent;
 - increase the rate of milk production by the female ruminant(s) by at least about five percent, and desirably by at least about eight percent;
 - increase the rate of 4% fat-corrected milk production by the female ruminant(s) by at least about eight percent, and desirably by at least about twelve percent;
 - increase the concentration of true protein in milk produced by the female ruminant(s) by at least about three percent, and desirably by at least about six percent;
 - increase the concentration of fat in milk produced by the female ruminant(s) by at least about eight percent, and desirably by at least about twelve percent;
 - increase the concentration of lactose in milk produced by the female ruminant(s) by at least about two percent, and desirably by at least about four percent; and/or
 - increase the concentration of total solids in milk produced by the female ruminant(s) by at least about two percent, and desirably by at least about four percent;
- as compared to any female ruminant(s) that does not ingest any sugar alcohol(s) during the pre-partum period and/or during the early post-partum period.

Some non-exhaustive examples of suitable daily sugar alcohol ingestion rates by the female ruminant(s) during the pre-partum period and by the female ruminant(s) during the subsequent early post-partum period that are believed effective to increase one or more of the variable(s) I, J, K, L, M, N, and/or O associated with the female ruminant(s), as compared to the value of the variable(s) exhibited by any comparative female ruminant(s) that do not ingest any sugar alcohol(s) during the pre-partum period and/or do not ingest any sugar alcohol(s) during the subsequent early post-partum period, are ingestion rates ranging from about five grams per day per female ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols and more typically from about fifty grams per day per female ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols. As an alternative approach, the ingestion rate ranging from about five grams per day per female ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols may permissibly be an ingestion rate over the pre-partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period) that ranges from an average of about five grams per day per female ruminant to an average of about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period). Also, as an alternative approach, the more typical ingestion rate ranging from about fifty grams per day per female ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols may permissibly be an ingestion rate that ranges from an average of about fifty grams per day per female ruminant to an average of about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-

14

partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period).

Two non-exhaustive, though exemplary, daily sugar alcohol ingestion rates by the female ruminant(s) during the pre-partum period and by the female ruminant(s) during the subsequent early post-partum period within the range presented immediately above that are effective to increase one or more of the variable(s) I, J, K, L, M, N, and/or O associated with the female ruminant(s), as compared to the value of the variable(s) I, J, K, L, M, N, and/or O exhibited by any comparative female ruminant(s) that do not ingest any sugar alcohol(s) during the pre-partum period and/or do not ingest any sugar alcohol(s) during the subsequent early post-partum period, are (1) a daily sugar alcohol ingestion rate of about seventy-five grams to about one hundred grams of any individual sugar alcohol or any mixture of any sugar alcohols per female ruminant per day and (2) a daily sugar alcohol ingestion rate of about one hundred fifty to about one hundred eighty grams of any individual sugar alcohol or any mixture of any sugar alcohols per female ruminant per day.

As an alternative approach to the daily sugar alcohol ingestion rate ranging from about seventy-five grams to about one hundred grams of sugar alcohol(s) per female ruminant over the pre-partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period), the sugar alcohol ingestion rate may permissibly be an ingestion rate that ranges from an average of about seventy-five grams per day per female ruminant to an average of about one hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period). Likewise, as an alternative approach to the daily sugar alcohol ingestion rate ranging from about one hundred fifty grams to about one hundred eighty grams of sugar alcohol(s) per female ruminant over the pre-partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period), the sugar alcohol ingestion rate may permissibly be an ingestion rate over any portion that ranges from an average of about one hundred fifty grams per day per female ruminant to an average of about one hundred eighty grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols over the pre-partum period (or any portion of the pre-partum period) and over the early post-partum period (or any portion of the early post-partum period).

Following the early post-partum period, the lactating ruminants may be fed according to any appropriate feeding protocol to optimize milk production, milk component production, ruminant feed intake, and/or ruminant health parameters, as desired. Some exemplary components and component concentration ranges for feed compositions that may be provided to female ruminants following the early post-partum period are detailed in Table 5 below.

TABLE 5

Component	Weight Percent (Dry Basis)*
Corn Silage (32% DM)	about 25 to about 30
Cracked Corn	about 15 to about 20
Alfalfa Hay	about 10 to about 15
Alfalfa Haylage	about 10 to about 15

TABLE 5-continued

Component	Weight Percent (Dry Basis)*
Peak Plus® 37 Formula Feed	about 5 to about 10
Fresh Tran Plus® Formula Feed	about 8 to about 13
Condition Plus® Formula Feed	about 3 to about 6
QLF® 4-19 Formula Feed	about 3 to about 6

*Based on Total Dry Matter Weight of the Feed Composition Provided After the Early Post-Partum Period

Peak Plus® 37 formula feed, Fresh Tran Plus® formula feed, and Condition Plus® formula feed are each available from Land O'Lakes Farmland Feed, LLC, Inc. of Arden Hills, Minn., and QLF® 4-19 formula feed is available from Quality Liquid Feeds, Inc. of Dodgeville, Wis.

As part of the feed composition provided after the early post-partum period or along with the feed composition provided after the early post-partum period, the lactating ruminants may optionally be provided with any sugar alcohol or any mixture or combination of different sugar alcohols to help optimize milk production, milk component production, ruminant feed intake, and/or ruminant health parameters, as desired. Some non-exhaustive examples of suitable daily sugar alcohol ingestion rates by female ruminant(s) after the early post-partum period are ingestion rates ranging from about five grams per day per female ruminant to about two hundred grams per day per female ruminant of any individual sugar alcohol or any mixture of any sugar alcohols.

Various analytical techniques are employed herein. An explanation of these techniques follows. All values presented in this document for a particular parameter, such as weight percent true protein, weight percent fat, weight percent lactose, weight percent non-protein nitrogen, and weight percent total solids, are based on the "as is" sample and are therefore on a "wet basis", unless otherwise specified herein.

Property Determination and Characterization Techniques

Dry Matter Basis Determination

To determine the dry matter weight (or dry matter basis or dry basis) of a particular sample, the sample is first weighed. The weighed sample is then dried in an oven at a temperature that is adequate to drive off moisture from the sample without degrading the sample components, such as a temperature ranging from about 100° C. to about 110° C. The oven drying is continued until the weight of the dried sample remains constant, despite additional oven drying.

Total Solids Determination

To determine the weight percent total solids, wet basis, in a sample, the actual weight of total solids is determined by analyzing the sample in accordance with Method #925.23 (33.2.09) of *Official Methods of Analysis*, Association of Official Analytical Chemists (AOAC) (16th Ed., 1995). The weight percent total solids, wet basis, is then calculated by dividing the actual weight of total solids by the actual weight of the sample.

Total Protein Determination

To determine the percent of total protein, wet basis, in a sample, the actual weight of total protein is determined in accordance with Method #991.20 (33.2.11) of *Official Methods of Analysis*, Association of Official Analytical Chemists

(AOAC) (16th Ed., 1995). The value determined by the above method yields "total Kjeldahl nitrogen," which is equivalent to "total protein" since the above method incorporates a factor that accounts for the average amount of nitrogen in protein. Since any and all total Kjeldahl nitrogen determinations presented herein are based on the above method, the terms "total Kjeldahl nitrogen" and "total protein" are used interchangeably herein. Furthermore, those skilled in the art will recognize that the term "total Kjeldahl nitrogen" is generally used in the art to mean "total protein" with the understanding that the factor has been applied. The weight percent total protein, wet basis, is calculated by dividing the actual weight of total protein by the actual weight of the sample.

True Protein Determination

The weight percent of true protein, wet basis, for a particular sample is calculated after first determining the wet basis weight percent of total Kjeldahl nitrogen and the wet basis weight percent of non-protein nitrogen in the sample. The wet basis weight percent of total Kjeldahl nitrogen in the sample is determined using the method referenced above. The wet basis weight percent of non-protein nitrogen (NPN) in the sample is determined in accordance with Method #991.21 (33.2.12) of *Official Methods of Analysis*, Association of Official Analytical Chemists (AOAC) (16th Ed., 1995). The weight percent of true protein, wet basis, in the sample is then determined by subtracting the wet basis weight percent of non-protein nitrogen in the sample from the wet basis weight percent of total Kjeldahl nitrogen in the sample.

Lactose Determination

To determine the weight percent lactose, wet basis, in a liquid sample, the weight of the liquid sample is first determined. The actual weight of lactose in the liquid sample may then be determined using analysis kit number 176-303, that is available from Boehringer-Mannheim of Indianapolis, Ind. in accordance with the procedural instructions included with analysis kit number 176-303. The weight percent lactose, wet basis, in the liquid sample is then calculated by dividing the actual weight of lactose in the liquid sample by the actual weight of the liquid sample.

Fat Determination

To determine the weight percent total fat, wet basis, in a sample, the actual weight of fat in the sample is determined in accordance with Method #974.09 (33.7.18) of *Official Methods of Analysis*, Association of Official Analytical Chemists (AOAC) (16th Ed., 1995). The weight percent total fat, wet basis, is then calculated by dividing the actual weight of fat in the sample by the actual weight of the sample.

Fat-Corrected Milk

To convert a particular quantity (weight) of a milk sample to the quantity (weight) of Fat-Corrected Milk, based on a correction to a concentration of four weight percent fat, based on the total weight off the Fat-Corrected Milk, the following equation is employed:

$$4 \text{ wt \% FCM} = \text{Original Milk Weight} \times (0.4 + (0.15 \times \text{TF}_{OM}))$$

where:

the term 4 wt % FCM means the calculated weight of Fat-Corrected Milk, based on a correction to a concen-

17

tration of four weight percent fat, based on the total weight of the Fat-Corrected Milk, the term Original Milk Weight means the weight of the original milk sample that is being corrected to a four weight percent fat basis, and % TF_{OM} is the weight % total fat in the original milk sample, based on the total weight of the original milk sample.

Non-Esterified Fatty Acid Determination

To determine the weight percent of non-esterified fatty acid NEFA, wet basis, in a sample of blood, the blood sample is analyzed by an enzymatic colorimetric method (ACS-ACOD) using the NEFA C diagnostic kit (WAKO Chemicals USA, Richmond, Va.) in combination with an Hitachi 704 Automated Chemistry Analyzer (Hitachi Ltd., Tokyo, Japan). The enzymatic colorimetric method utilizes acyl-CoA synthetase (ACS) and acyl-CoA oxidase (ACOD) to produce a substance that may be measured colorimetrically. The NEFA analysis is conducted in accordance with the NEFA C ACS-ACOD Method instructions that WAKO Chemicals USA provides along with the NEFA C diagnostic kit.

The present invention is more particularly described in the following examples which are intended as illustrations only since numerous modifications and variations within the scope of the present invention will be apparent to those skilled in the art.

EXAMPLES

Example One and Example Two provided below demonstrate effects of feeding female ruminants a control feed in combination with sugar alcohol, during a pre-partum period only, in accordance with the present invention, as compared to the effects of feeding female ruminants during the pre-partum period with the control feed in the absence of any sugar alcohol. Example Two provided below further demonstrates effects of feeding female ruminants the control feed in combination with sugar alcohol during both a pre-partum period and a post birth period, in accordance with the present invention, as compared to effects of feeding female ruminants during both the pre-partum period and the post birth period with the control feed in the absence of the sugar alcohol.

In Examples One and Two, the pre-partum period extended from three weeks prior to the pregnant ruminants giving birth (designated as "week -3") and ended at the time the pregnant ruminants gave birth. Thus, in Examples One and Two, the pre-partum period extended from week -3 through week -1. Also, in Examples One and Two, the early post-partum period extended from the day the female ruminants gave birth (i.e., "week +1") and ended four weeks after the female ruminants gave birth. Thus, in Examples One and Two, the early post-partum period extended from week +1 through week +4.

Furthermore, each trial conducted in support of Examples One and Two extended beyond the early post-birth period, namely from the fifth week after the female ruminants gave birth (i.e., "week +5") through the eighth week after the female ruminants gave birth (i.e., "week +8"). However, the feeding regimen from week +0.5 through week +8 during the feeding trials of Example One differed from the feeding regimen from week +5 through week +8 during the feeding trials of Example Two. On the other hand, the feeding regimens from week +5 through week +8 for the different feeding trials of Example One were all the same, or essentially the same, as each other. Likewise, the feeding regimen from week +5 through week +8 for the different feeding trials of Example Two were all the same, or essentially the same, as each other.

Six separate trials are reflected in Examples One and Two. Two of the trials are encompassed within Example One, and

18

four of the trials are encompassed within Example Two. Each of the six different trials extended from week -3 of the pre-partum period, through the entire early post birth period (i.e., from week +1 through week +4), and ended at the end of week +8. There were two control trials (Control Trial #1 and Control Trial #2), and there were four separate trials in accordance with the present invention.

When reference is made herein to the (or both) "Control Trials," it is to be understood this is a reference to both Control Trial #1 and Control Trial #2, unless otherwise indicated. In both control trials, a pre-partum control feed was provided during the pre-partum period (weeks -3 through -1) and a first post-partum control feed was provided during the early post-partum period (weeks +1 through +4). No sugar alcohol was included in or provided along with the pre-partum control feed during the pre-partum period in either of the control trials, and no sugar alcohol was included in or provided along with the first post-partum control feed during the early post-partum period in either of the two control trials.

In Control Trial #1, a second post-partum control feed that did not include any sugar alcohol was provided from week +5 through week +8. On the other hand, in Control Trial #2, a third post-partum control feed that was modified to include sugar alcohol was provided from week +5 through week +8. The second post-partum control feed and the third post-partum control feed were the same, or essentially the same, with the exception that the second post-partum control feed did not include any sugar alcohol, whereas the third post-partum control feed did include sugar alcohol.

The third and fourth trials, which individually and collectively represent one approach to practicing the present invention, are referred to herein as Pre-Partum Trial #1 and Pre-Partum Trial #2. When reference is made herein to the (or both) "Pre-Partum Trials," it is to be understood this is a reference to both Pre-Partum Trial #1 and Pre-Partum Trial #2, unless otherwise indicated. In both Pre-Partum Trials, the pre-partum control feed was provided during the pre-partum period (weeks -3 through -1) and the first post-partum control feed was provided during the early post-partum period (weeks +1 through +4). The pre-partum control feed used in both Pre-Partum Trials during the pre-partum period was modified, as indicated below, to incorporate a particular sorbitol dosage. No sugar alcohol was included in or provided along with the first post-partum control feed fed to the female ruminants of either Pre-Partum Trial during the early post-partum period.

In Pre-Partum Trial #1, the second post-partum control feed that did not include any sugar alcohol was provided from week +5 through week +8. On the other hand, in Pre-Partum Trial #2, the third post-partum control feed that did include sugar alcohol was provided from week +5 through week +8. Again, the second post-partum control feed and the third post-partum control feed were the same, or essentially the same, with the exception that the second post-partum control feed did not include any sugar alcohol, whereas the third post-partum control feed did include sugar alcohol.

The fifth trial, which represents another approach to practicing the present invention, is referred to herein as Pre/Post Trial #1. In Pre/Post Trial #1, the pre-partum control feed was provided during the pre-partum period (weeks -3 through -1), the first post-partum control feed was provided during the early post-partum period (weeks +1 through +4), and the second post-partum control feed was provided from week +5 through week +8. The pre-partum control feed used in Pre/Post Trial #1 during the pre-partum period was modified, as indicated below, to incorporate a particular sorbitol dosage. The first post-partum control feed used in Pre/Post Trial #1 during the early post-partum period was modified, as indicated below, to incorporate a particular sorbitol dosage. Also, the third post-partum control feed used in Pre/Post Trial #1

19

during weeks +5 through +8 following the early post-partum period incorporated a particular sorbitol dosage, as indicated below.

A sixth trial, which represents yet another approach to practicing the present invention, is referred to herein as Pre/Post Trial #2. In Pre/Post Trial #2, the pre-partum control feed was provided during the pre-partum period (weeks -3 through -1), the first post-partum control feed was provided during the early post-partum period (weeks +1 through +4), and the third post-partum control feed was provided from week +5 through week +8. The pre-partum control feed used in Pre/Post Trial #2 during the pre-partum period was modified, as indicated below, to incorporate a particular sorbitol dosage. The first post-partum control feed used in Pre/Post Trial #2 during the early post-partum period was modified, as indicated below, to incorporate a particular sorbitol dosage. Also, the third post-partum control feed used in Pre/Post Trial #2 during weeks +5 through +8 following the early post-partum period incorporated a particular sorbitol dosage, as indicated below. Pre/Post Trial #1 and Pre/Post Trial #2 (a) differed from each other in the sorbitol dosage that was incorporated in the pre-partum control feed provided during the pre-partum period and (b) differed from each other in the sorbitol dosage that was incorporated in the first post-partum control feed provided during the early post-partum period.

In Examples One and Two, the pre-partum control feed had the composition set forth in Table 6 below and the pre-partum control feed had the nutrient composition set forth in Table 7 below:

TABLE 6

Ingredient Composition of Pre-Partum Control Feed		
Component	Weight Percent (As-Is Basis)*	Weight Percent (Dry Basis)**
Corn Silage (38% DM)	60.00	38.66
Concentrate***	24.00	36.66
Grass Hay	16.00	24.68

*Based on Total (As-Is) Weight of Pre-Partum Control Feed

**Based on Total Dry Matter Weight of Pre-Partum Control Feed

***TRANSCOW ® Complete 20 Pre-Fresh ration available from Land O'Lakes Farmland Feed, LLC.

TABLE 7

Nutrient Composition of Pre-Partum Control Feed	
Component	Value
Moisture (as is basis)	41.0 wt. %*
Net Energy for Lactation	0.724 Mc/lb
Crude Protein	14.7 wt. %**
Non-Fiber Carbohydrate (NFC)	37.3 wt. %**
Soluble Acid Detergent Fiber (ADF)	23.0 wt. %*
Soluble Neutral Detergent Fiber (NDF)	38.3 wt. %**
Soluble Neutral Detergent Fiber (NDF) from Forage	26.0 wt. %**
Forage	63.4 wt. %**
Crude Fat	2.6 wt. %**
Calcium	1.0 wt. %**
Phosphorous	0.37 wt. %**
Magnesium	0.47 wt. %**
Potassium	1.1 wt. %**

*Based on Total (As-Is) Weight of Pre-Partum Control Feed

**Based on Total Dry Matter Weight of Pre-Partum Control Feed

In Examples One and Two, the first post-partum control feed employed during the early post-partum period (week +1 through week +4) had the composition set forth in Table 8 below, the feed concentrate that was included in the first post-partum control feed had the composition set forth in

20

Table 9 below, and the first post-partum control feed had the nutrient composition set forth in Table 10 below:

TABLE 8

Ingredient Composition of First Post-Partum Control Feed		
Component	Weight Percent (As-Is Basis)*	Weight Percent (Dry Basis)**
Corn Silage (32% DM)	35.76	21.51
Haylage (31% DM)	26.49	15.43
Alfalfa Hay (160 FRV)	6.62	10.71
Grass Hay	3.97	6.42
Concentrate	27.16	45.93

*Based on Total (As-Is) Weight of First Post-Partum Control Feed

**Based on Total Dry Matter Weight of First Post-Partum Control Feed

TABLE 9

Ingredient Composition of Feed Concentrate of First Post-Partum Control Feed	
Component	Weight Percent (As-Is Basis)*
Soybean Hulls	8.19
Molasses	0.63
Soybean Meal (48 wt % true protein)	13.65
Ground Corn & Shelled Corn	36.57
Dried Distiller's Grain with Solubles	12.14
Wheat Midds	5.56
Whole Cottonseed	10.19
SUREPRO ® Rumen Bypass Protein	4.39
MEGALAC ® Rumen Bypass Fat	0.73
Choice White Grease	1.12
Vitamins & Minerals	6.83

*Based on Total (As-Is) Weight of Feed Concentrate of First Post-Partum Control Feed

TABLE 10

Nutrient Composition of First Post-Partum Control Feed	
Component	Value
Moisture (as is basis)	46.8 wt. %*
Net Energy for Lactation	31.011 Mc/lb
Crude Protein	18.6 wt. %***
Undegradable Protein	33.5 wt. %**
Degradable Protein	66.4 wt. %**
Soluble Protein	34.8 wt. %**
Urea	0.06 wt. %***
Non-Fiber Carbohydrate (NFC)	36.1 wt. %***
Soluble Acid Detergent Fiber (ADF)	20.6 wt. %***
Soluble Neutral Detergent Fiber (NDF)	30.8 wt. %***
Soluble Neutral Detergent Fiber (NDF) from Forage	20.6 wt. %***
Forage	54.1 wt. %***
Crude Fat	5.1 wt. %***
Calcium	0.99 wt. %***
Phosphorous	0.42 wt. %***
Magnesium	0.32 wt. %***
Potassium	1.6 wt. %***

*Based on Total (As-Is) Weight of First Post-Partum Control Feed

**Based on Total Weight of Crude Protein in First Post-Partum Control Feed

***Based on Total Dry Matter Weight of First Post-Partum Control Feed

In Example One, the second postpartum control feed employed from week +5 through week +8 had the composition set forth in Table 11 below. In Example Two, the third post-partum control feed employed from week +5 through week +8 had the composition set forth in Table 11, with the exception that the third post-partum control feed was subsequently modified to incorporate sugar alcohol, as later indicated herein.

21

TABLE 11

Ingredient Composition of Second and Third* Post-Partum Control Feeds	
COMPONENTS	WEIGHT PERCENT (DRY BASIS)*
alfalfa haylage	13
alfalfa hay	13
corn silage	26
corn, cracked	18.8
PEAK PLUS ® 37 formula feed	8
FRESH TRAN PLUS ® formula feed	10.4
CONDITION PLUS ® formula feed	4.5
QLF ® 4-19 formula feed	4.7
other minor ingredients	1.6

*Based on Total Dry Matter Weight of Second Post-Partum Control Feed

*The third post-partum control feed was subsequently modified, as indicated subsequently herein, to incorporate sugar alcohol

The ingredient list for the second post-partum control feed of Table 11 and for the third post-partum control feed of (does not reflect modification to incorporate sugar alcohol) of Table 11 is detailed further in Table 12 below:

TABLE 12

Ingredient Composition of Second and Third* Post-Partum Control Feeds	
COMPONENT	WEIGHT PERCENT (DRY BASIS)***
alfalfa haylage	13
alfalfa hay	13
corn silage	26
cracked corn	18.8
QLF ® 4-19 formula feed	4.7
whole cotton seed	4.2*
48 wt. % protein soybean meal	7.8*
wheat midds	1.9*
soy hulls	1.1*
SOYPASS™ protein-modified soybean meal	2.6*
dried distiller's grain with solubles	1.9*
molasses	0.5*
MEGALAC ® rumen-bypass fat base	0.9*
other minor ingredients	3.7**

*derived from PEAK PLUS ® 37 formula feed, FRESH IRAN PLUS ® formula feed, and/or CONDITION PLUS ® formula feed

**derived from PEAK PLUS ® 37 formula feed, FRESH TRAN PLUS ® formula feed, and/or CONDITION PLUS ® formula feed and from other minor ingredients listed in Table 11

***Based on Total Dry Matter Weight of Second Post-Partum Control Feed

*The third post-partum control feed was subsequently modified, as indicated subsequently herein, to incorporate sugar alcohol

The second post-partum control feed and the third post-partum control feed (does not reflect modification to incorporate sugar alcohol) had the nutrient composition set forth in Table 13 below.

TABLE 13

Nutrient Composition of Second and Third* Post-Partum Control Feeds	
NUTRIENT	WEIGHT PERCENT (DRY BASIS)*
crude protein	18.1
acid detergent soluble fiber (ADF)	18.9
neutral detergent soluble fiber (NDF)	27.5
fat	6
calcium	1.05
phosphorous	0.52

*Based on Total Dry Matter Weight of Second Post-Partum Control Feed

*The third post-partum control feed was subsequently modified, as indicated subsequently herein, to incorporate sugar alcohol

In Control Trial #2, sorbitol syrup was incorporated by blending into the third post-partum control feed in a ratio of sorbitol to the third post-partum control feed that was

22

designed to provide the female ruminants of Control Trial #2 with about 100 grams of sorbitol per day from week +5 through week +8 of each control trial, based on historical feed intake data for the female ruminants of Control Trial #2. Again, the second post-partum control feed used in Control Trial #1 during weeks +5 through +8 following the early post-partum period did not include any sugar alcohol.

In both Pre-Partum Trials, sorbitol syrup was blended with the pre-partum control feed in a ratio of sorbitol to the pre-partum control feed that was designed to provide the female ruminants of both Pre-Partum Trials with about 75 grams of sorbitol per day during the pre-partum period (weeks -3 through -1), based on historical feed intake data for the female ruminants of the two Pre-Partum Trials. No sugar alcohol was included in or provided along with the first post-partum control feed fed to the female ruminants of either Pre-Partum Trial during the early post-partum period. In Pre-Partum Trial #2, sorbitol syrup was incorporated by blending into the third post-partum control feed in a ratio of sorbitol to the third post-partum control feed that was designed to provide the female ruminants of Pre-Partum Trial #2 with about 100 grams of sorbitol per day from week +5 through week +8 of each control trial, based on historical feed intake data for the female ruminants of Pre-Partum Trial #2. Again, the second post-partum control feed used in Pre-Partum Trial #1 during weeks +5 through +8 following the early post-partum period did not include any sugar alcohol.

In Pre/Post Trial #1, sorbitol syrup was blended with the pre-partum control feed in a ratio of sorbitol to the pre-partum control feed that was designed to provide the female ruminants of Pre/Post Trial #1 with about 150 grams of sorbitol per day during the pre-partum period (weeks -3 through -1), based on historical feed intake data for the female ruminants of Pre/Post Trial #1. In Pre/Post Trial #1, sorbitol syrup was blended with the first post-partum control feed in a ratio of sorbitol to the first post-partum control feed that was designed to provide the female ruminants of Pre/Post Trial #1 with about 125 grams of sorbitol per day during the early post-partum period (weeks +1 through +4), based on historical feed intake data for the female ruminants of Pre/Post Trial #1. In Pre/Post Trial #1, sorbitol syrup was blended with the third post-partum control feed in a ratio of sorbitol to the third post-partum control feed that was designed to provide the female ruminants of Pre/Post Trial #1 with about 100 grams of sorbitol per day from week +5 through week +8 of Pre/Post Trial #1, based on historical feed intake data for the female ruminants of Pre/Post Trial #1.

In Pre/Post Trial #2, sorbitol syrup was blended with the pre-partum control feed in a ratio of sorbitol to the pre-partum control feed that was designed to provide the female ruminants of Pre/Post Trial #2 with about 75 grams of sorbitol per day during the pre-partum period (weeks -3 through -1), based on historical feed intake data for the female ruminants of Pre/Post Trial #2. In Pre/Post Trial #2, sorbitol syrup was blended with the first post-partum control feed in a ratio of sorbitol to the first post-partum control feed that was designed to provide the female ruminants of Pre/Post Trial #2 with about 75 grams of sorbitol per day during the early post-partum period (weeks +1 through +4), based on historical feed intake data for the female ruminants of Pre/Post Trial #2. In Pre/Post Trial #2, sorbitol syrup was blended with the third post-partum control feed in a ratio of sorbitol to the third post-partum control feed that was designed to provide the female ruminants of Pre/Post Trial #2 with about 100 grams of sorbitol per day from week +5 through week +8 of Pre/Post Trial #2, based on historical feed intake data for the female ruminants of Pre/Post Trial #2.

During the pre-partum period, for all cows utilized in Example One or Example Two, the pre-partum control feed, as modified to include any sorbitol indicated above for the different trials, was placed in the feeding troughs of the different cows participating in the different trials once daily in the morning. Thereafter, these different pre-partum feeds (the pre-partum control feed, including any incorporated sorbitol dosage of a particular trial during the pre-partum period) of the different trials were lightly stirred, separately and individually, in front of the cows of the different trials three times per day during the pre-partum period to encourage additional feed ingestion by the cows.

Leftover rations from the previous day's feeding were collected and weighed from each feeding trough during the pre-partum period, prior to feeding the test cows on a subsequent day. The cows of the different trials received a sufficient amount of the pre-partum to ensure at least about ten weight percent of the pre-partum feeds of the different trials remained in the feeding troughs of each trial each day of the pre-partum period, based on the amount of the different pre-partum feeds of the different trials provided at the beginning of each day. Feed refusals were measured daily during the pre-partum period, and water was supplied ad libitum.

During the early post-partum period, for all cows utilized in Example One or Example Two, the first post-partum control feed, as modified to include any sorbitol indicated above for the different trials, was placed in the feeding troughs of the different cows participating in the different trials once daily in the morning. Thereafter, these first post-partum feeds (the first post-partum control feed, including any incorporated sorbitol dosage of a particular trial during the early post-partum period) of the different trials were lightly stirred, separately and individually, in front of the cows of the different trials three times per day during the early post-partum period to encourage additional feed ingestion by the cows.

Leftover rations from the previous day's feeding were collected and weighed from each feeding trough during the early post-partum period, prior to feeding the test cows on a subsequent day. The cows of the different trials received a sufficient amount of the first post-partum feed to ensure at least about ten weight percent of the first post-partum feeds of the different trials remained in the feeding troughs of each trial each day of the early post-partum period, based on the amount of the different first post-partum feeds of the different trials provided at the beginning of each day. Feed refusals were measured daily during the early post-partum period, and water was supplied ad libitum.

During weeks +5 through +8 following the early post-partum period, for all cows utilized in Example One, the second post-partum control feed (which did not include any added sugar alcohol as explained elsewhere herein) was placed in the feeding troughs of the different cows participating in the different trials once daily in the morning. Thereafter, the second post-partum control feed were lightly stirred, separately and individually, in front of the cows of the different trials three times per day during the weeks +5 through +8 to encourage additional feed ingestion by the cows.

Leftover rations from the previous day's feeding were collected and weighed from each feeding trough during weeks +5 through +8, prior to feeding the test cows on a subsequent day. The cows of the different trials received a sufficient amount of the second post-partum control feed to ensure at least about ten weight percent of the second post-partum control feed of the different trials remained in the feeding troughs of each trial each day during weeks +5 through +8, based on the amount of the second post-partum control feed of the different trials provided at the beginning of each day.

Feed refusals were measured daily during weeks +5 through +8, and water was supplied ad libitum.

During weeks +5 through +8 following the early post-partum period, for all cows utilized in Example Two, the third post-partum control feed, as modified to include sorbitol as indicated above for the different trials of Example Two, was placed in the feeding troughs of the different cows participating in the different trials once daily in the morning. Thereafter, these third post-partum feeds (the third post-partum control feed, including any incorporated sorbitol dosage of a particular trial during weeks +5 through +8) of the different trials were lightly stirred, separately and individually, in front of the cows of the different trials three times per day during the weeks +5 through +8 to encourage additional feed ingestion by the cows.

Leftover rations from the previous day's feeding were collected and weighed from each feeding trough during weeks +5 through +8, prior to feeding the test cows on a subsequent day. The cows of the different trials received a sufficient amount of the third post-partum feed to ensure at least about ten weight percent of the third post-partum feeds of the different trials remained in the feeding troughs of each trial each day during weeks +5 through +8, based on the amount of the different third post-partum feeds of the different trials provided at the beginning of each day. Feed refusals were measured daily during weeks +5 through +8, and water was supplied ad libitum.

Each cow of each of the six different trials (Control Trial #1, Control Trial #2, Pre-Partum Trial #1, Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) received routine care and management consistent with appropriate recommendations in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (1st edition, March 1988). This care and management was provided throughout the pre-partum period, the early post-partum period, and the four week period (weeks +5 through +8) following the early post-partum period.

Each cow of each of the six different trials (Control Trial #1, Control Trial #2, Pre-Partum Trial #1, Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) was milked three times daily and the weight of produced milk by each cow was recorded at each milking. The milk from each cow was sampled once per week ($\frac{1}{3}$ of the sample volume from each of the three milkings occurring on the weekly milk sampling day) and was analyzed for true protein, total fat, lactose, and total solids, as detailed in the property determination and characterization techniques presented above. Additionally, samples of blood were periodically obtained from each cow during the four trials (Control Trial 2, Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) encompassed in Example Two and were analyzed for non-esterified fatty acid (NEFA) content as detailed in the property determination and characterization techniques presented above. No NEFA analysis was conducted on the cows employed in Control Trial #1 or Pre-Partum Trial #1 that are the subject of Example One.

For the data underlying the mean data presented in Example One, statistical analysis was employed for comparing the results of feeding the female ruminants assigned to Control Trial #1 according to the feeding protocol of Control Trial #1 versus the results of feeding the female ruminants assigned to Pre-Partum Trial #1 according to the feeding protocol of Pre-Partum Trial #1. Likewise, for the data underlying the mean data presented in Example Two, statistical analysis was employed for comparing the results of feeding the female ruminants assigned to Control Trial #2 according to the feeding protocol of Control Trial #2; the results of

feeding the female ruminants assigned to Pre-Partum Trial #2 according to the feeding protocol of Pre-Partum Trial #2, the results of feeding the female ruminants assigned to Pre/Post Trial #1 according to the feeding protocol of Pre/Post Trial #1, and the results of feeding the female ruminants assigned to Pre/Post Trial #2 according to the feeding protocol of Pre/Post Trial #2. For each individual trial, all data provided in Tables 14-27 below for that individual trial is based on individual data collected for each cow, then-present, as least square means of the data over all cows present in that individual trial at the time the individual data was recorded, unless otherwise indicated. The data provided in Tables 14-27 below are these least square means.

Data for parameters presented in Tables 14-27 was analyzed using the general linear model (GLM) statistical procedure of SASTM statistical analysis software for a randomized complete block design that included both the feed regimen of the particular trial and the period (pre-partum period, early post-partum period, or period of weeks +5 through +8 following the early post-partum period) when the data was collected, in the model statement. The SASTM statistical analysis software is available from SAS Institute, Inc. of Cary, N.C.

Additionally, the PDiff function of the GLM statistical procedure was used to characterize the mean data values by providing for comparisons between mean data values for the female ruminants subjected to the particular feeding proto-

included in Control Trial #1 and Pre-Partum Trial #1. Five primiparous cows and fifteen multiparous cows were included in Control Trial #1; likewise, five primiparous cows and fifteen multiparous cows were included in Pre-Partum Trial #1. All cows included in Control Trial #1 and Pre-Partum Trial #1 were Holsteins.

All of the multiparous cows included in Example One were blocked by parity and by milk production, based on the level of milk production over a select period by the individual multiparous cows during the lactation period of the individual multiparous cows that ended most recently prior to participation in the trials of Example One. After being blocked by parity and milk production, the multiparous cows were randomly allotted to either Control Trial #1 or Pre-Partum Trial #1. The primiparous cows included in Control Trial #1 and Pre-Partum Trial #1 were blocked by body weight prior to participation in the trials of Example One. After being blocked by body weight, the primiparous cows were randomly allotted to either Control Trial #1 or Pre-Partum Trial #1.

The means of various parameters derived from the raw data of Pre-Partum Trial #1 and Control Trial #1 are provided in Table 14. The means provided in Table 14 are based solely on data from primiparous cows that were included in Pre-Partum Trial #1 and Control Trial #1.

TABLE 14

Variable	Weeks	Control Trial #1	Pre-Partum Trial #1	SEM	P
Dry Matter Feed Intake (lbs/day)	-3 through -1	18.1	17.8	1.32	
	+1 through +8	31.7	34.2	0.98	0.01
Milk Production (As Is Basis - lbs/day)	+1 through +8	71.7	71.7	1.71	
Milk Production (4.0% fat basis - lbs/day)	+1 through +8	73.7	79.3	2.62	
Fat in Produced Milk (wt %)	+1 through +8	3.76	4.2	0.13	0.01
True Protein in Produced Milk (wt %)	+1 through +8	2.70	2.9	0.043	0.001
Lactose in Produced Milk (wt %)	+1 through +8	4.74	4.98	0.029	0.0001
Total Solids in Produced Milk (wt %)	+1 through +8	12.1	13.0	0.14	0.01

cols of the six different trials (Control Trial #1, Control Trial #2, Pre-Partum Trial #1, Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) for particular test parameters or variables. The probability value P is a measure of the statistical probability that the differing parameter values derived from feeding female ruminants in differing ways may be explained solely by the difference between particular feeding protocols.

A P value of 0.05, as between data values for two particular trials, means five times out of 100 the results of the two particular trials under consideration may be explained by factors other than feeding protocols differences between the two particular trials under consideration. Likewise, a P value of 0.77, as between data values for two particular trials, means that 77 times out of 100, the difference between data values for the two particular trials may be explained by factors other than feeding protocols differences between the two particular trials under consideration. For purposes of comparing data in this document, P values of 0.10, or lower, are considered to be statistically significant. Thus, where a P value of 0.10 or less is returned for a particular variable, it is assumed the differing results are fully explained by feeding regimen differences between the two trials under consideration.

Example One

Example One includes Control Trial #1 and Pre-Partum Trial #1. Both primiparous cows and multiparous cows were

The data presented in Table 14 illustrates the pre-partum feeding of sorbitol according to Pre-Partum Trial #1 increased dry matter feed intake of the primiparous cows by +7.9% (P=0.01) versus the primiparous cows of Control Trial #1 during the period starting at the beginning of week +1 and extending through the end of week +8; this was accompanied by a 7.6% increase in production of 4% fat-corrected milk by the primiparous cows of Pre-Partum Trial #1 versus the primiparous cows of Control Trial #1 during the period starting at the beginning of week +1 and extending through the end of week +8. A plot of the daily dry matter feed intake per cow is provided in FIG. 1 for the primiparous cows of Pre-Partum Trial #1 versus the primiparous cows of Control Trial #1 is presented, by week, extending from the beginning of the pre-partum period (weeks -3 through -1), through the early post-partum period (weeks +1 through +4), and through week +8.

Additionally, the pre-partum feeding of sorbitol according to Pre-Partum Trial #1 increased the fat concentration in the produced milk by 11.7% (P=0.01), increased the true protein concentration in the produced milk by 7.4% (P=0.001), increased the lactose concentration in the produced milk by 5.1% (P=0.0001), and increased the total solids concentration in the produced milk by 7.4% (P=0.01) for the primiparous cows of Pre-Partum Trial #1 versus the primiparous cows of Control Trial #1, as determined over the period starting at the

beginning of week +1 and extending through the end of week +8. Collectively, this data of Table 14 illustrates the pre-partum feeding of sorbitol according to Pre-Partum Trial #1 significantly improved the post-partum feed intake, 4% fat-corrected milk production, and milk component concentrations of the primiparous cows of Pre-Partum Trial #1 versus the primiparous cows of Control Trial #1.

Additional means of various parameters derived from the raw data of Pre-Partum Trial #1 and Control Trial #1 are provided in Table 15. The means provided in Table 15 are based solely on data from multiparous cows that were included in Pre-Partum Trial #1 and Control Trial #1.

TABLE 15

Variable	Weeks	Control Trial #1	Pre-Partum Trial #1	SEM	P
Dry Matter Feed Intake (lbs/day)	-3 through -1	28.1	29.9	0.79	
	+1 through +8	40.6	44.5	0.60	0.0001
Milk Production (As Is Basis - lbs/day)	+1 through +8	91.5	99.9	1.04	0.0001
Milk Production (4.0% fat basis - lbs/day)	+1 through +8	87.7	98.6	1.59	0.09
Fat in Produced Milk (wt %)	+1 through +8	3.35	3.50	0.081	
True Protein in Produced Milk (wt %)	+1 through +8	2.81	2.82	0.026	
Lactose in Produced Milk (wt %)	+1 through +8	4.75	4.77	0.017	
Total Solids in Produced Milk (wt %)	+1 through +8	11.8 ^b	12.0 ^{a,b}	0.086	

The data presented in Table 15 illustrates the pre-partum feeding of sorbitol according to Pre-Partum Trial #1 increased dry matter feed intake of the multiparous cows by +9.6% (P=0.0001) and increased milk production by 9.2% (P=0.0001) by the multiparous cows of Pre-Partum Trial #1 versus the multiparous cows of Control Trial #1 during the period starting at the beginning of week +1 and extending through the end of week +8. This large and significant milk production increase was accompanied by a large and significant 4% fat-corrected milk production increase of 12.4% (P=0.09) by the multiparous cows of Pre-Partum Trial #1 versus the multiparous cows of Control Trial #1 during the period starting at the beginning of week +1 and extending through the end of week +8.

A plot of the daily dry matter feed intake per cow is presented in FIG. 2 for the multiparous cows of Pre-Partum Trial #1 versus the multiparous cows of Control Trial #1, by week, extending from the beginning of the pre-partum period (weeks -3 through -1), through the early post-partum period (weeks +1 through +4), and through week +8. Also, FIG. 3 is a plot of the daily milk production weights for the multiparous cows of Pre-Partum Trial #1 versus the multiparous cows of Control Trial #1, by week, extending from the beginning of the early post-partum period (weeks +1 through +4) through week +8.

Example Two

Example Two includes Control Trial #2, Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2. Only multiparous, Holstein cows were included in Control Trial #2, Pre-Partum Trial #1, Pre/Post Trial #1, and Pre/Post Trial #2. Eighteen multiparous cows were included in both Control Trial #2 and Pre-Partum Trial #2, while sixteen multiparous cows were included in Pre/Post Trial #1 and seventeen multiparous cows were included in Pre/Post Trial #2.

All of the cows included in Example Two were blocked by parity and by milk production, based on the level of milk production over a select period by the individual cows during the lactation period of the individual multiparous cows that ended most recently prior to participation in the trials of Example Two. After being blocked by parity and milk pro-

duction, the multiparous cows were randomly allotted to either Control Trial #2, Pre-Partum Trial #2, Pre/Post Trial #1, or Pre/Post Trial #2.

The data means presented in Table 16 below were covariately adjusted using only dry matter feed consumption rates (weight basis) of the cows present during the trials detailed in Table 16. On the other hand, the data means presented in Table 17 for Milk Production (As Is Basis) and for Milk Production (4% Fat Basis) were covariately adjusted using only pre-trial milk production rates (weight basis) of the cows present during the trials detailed in Table 17. Covariate adjustment entails the creation of a statistical adjustment

factor, considering the values of the selected covariate variable(s) for each individual cow prior to any feeding according to any trial of Example Two, that yields a standard base line using the covariate variable(s) employed for the test cows, and thereby statistically accounts for any variations in the covariate variable(s) employed, as between the different cows of the subject trials, prior to feeding in accordance with any of the different trials of Example Two.

In Table 16 through Table 21 that follow below, means of various parameters for multiparous cows that were determined in the course of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and Control Trial #2 are provided. In Tables 16 through 21, where a value appears in a particular row for P(01), the P(01) value that is provided is a measure of the statistical probability that differences between the mean data provided in that row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2. In Tables 16 through 21, if a P(01) value is presented in a particular row, another test for significance, namely the Least Significant Squares Difference (also referred to herein as "LSD") test, was conducted for the data of that row to detect which of the six possible different pairs of data in that particular row (i.e., (a) Pre-Partum Trial #2 versus Control Trial #2, (b) Pre/Post Trial #1 versus Control Trial #2, (c) Pre/Post Trial #3, (d) Pre-Partum Trial #2 vs. Pre/Post Trial #1, (e) Pre-Partum Trial #2 vs. Pre/Post Trial #2, and (f) Pre/Post Trial #1 vs. Pre/Post Trial #2) are significantly different (P<0.05) from each other. If the Least Squares Difference Test for data in a row showing a P(01) value returned a result showing any of the six possible pairs of data differed from each other at P<0.05, this pair (or these pairs) of data are indicated by differing superscript letters for each data of the pair (or pairs) in Tables 16-21.

Also, in Tables 16 through 21, where a value appears in a particular row for P(02), the P(02) value that is provided is a measure of the statistical probability that differences between the average of the three means provided in that row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in that row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1,

and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2. Additionally, in Tables 16-21, where a value appears in a particular row for P(03), the P(03) value that is provided is a measure of the statistical probability that differences between the means provided in that row for Pre-Partum Trial #2 versus the mean data provided in that row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2. Finally, in Tables 16-21, where a value appears in a particular row for P(04), the P(04) value that is provided is a measure of the statistical probability that differences between the means provided in that row for Pre/Post Trial #1 versus the mean data provided in that row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

In Table 16, means of dry matter feed intake data for multiparous cows derived from the raw data of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and Control Trial #2 are provided. Again, the data means presented in Table 16 above were covariately adjusted using only dry matter feed consumption rates (weight basis) of the cows present during the trials detailed in Table 16.

TABLE 16

	Week(s)	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
Dry Matter Intake (lbs/day)	Pre-partum	-3	31.9	30.9	29.6	31.9	1.12			0.15
		-2	36.2	33.5	34.6	36.3	1.29		0.15	
		-1	34.0	30.7	33.3	32.3	1.55		0.15	
	Post-partum	-3 through -1	34.2	31.8	32.6	33.2	1.02	0.17	0.10	
		+1	34.3	32.7	36.6	33.1	1.51			0.10
		+2	42.5	42.5	45.3	41.2	1.68			0.10
		+3	45.5	46.2	48.5	45.3	1.78			
		+4	49.3	50.1	51.2	49.8	1.78			
		+5	51.1	52.4	53.9	53.6	1.56			
		+6	52.7	53.9	53.7	54.2	1.65			
		+7	53.6	56.1	54.5	53.3	1.65			
		+8	54.2	53.8	57.1	55.0	1.87			
		+1 through +4	42.9	42.9	45.4	42.2	1.45			0.12
		+5 through +8	52.9	54.2	54.9	54.1	1.55			
		+1 through +8	47.9	48.4	50.1	48.2	1.39			
		-2 versus -1	-2.30	-2.88	-1.39	-3.91	1.14			0.13
		+1 versus -1	0.35	1.97	3.37	0.72	1.51			

P(01): Probability that means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2.

P(02): Probability that differences between the average of the three means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2.

P(03): Probability that differences between the means provided in row for Pre-Partum Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2.

P(04): Probability that differences between the means provided in row for Pre/Post Trial #1 versus the mean data provided in same row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

^{a,b}For any row where a P(01) value appears and superscript letters are provided for the data of that row, data without any common superscript letter differ from each other at a probability P of <0.05

50

Data presented in Table 16 illustrates sorbitol feeding according to the present invention decreased the dry matter feed intake (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) by the multiparous ruminants by 4.9% (P=0.17) versus the dry matter feed intake of the

multiparous cows of Control Trial #2, as measured over the pre-partum period of Example Two. Data presented in Table 16 further illustrates feeding of sorbitol according to the present invention decreased the dry matter feed intake by the multiparous ruminants of Pre-Partum Trial #2 by 7.0% (P=0.10) versus the dry matter feed intake of the multiparous cows of Control Trial #2, as measured over the pre-partum period of Example Two.

Data presented in Table 16 further indicates sorbitol feeding at a higher daily dosage during the pre-partum period and the early post-partum period according to Pre/Post Trial #1, as compared to the lower daily sorbitol dosage during the pre-partum period and the early post-partum period according to Pre/Post Trial #2, had a greater effect on feed intake of the multiparous ruminants as evidenced by a 7.6% (P=0.12) greater daily rate of dry matter feed intake for the ruminants of Pre/Post Trial #1 versus the ruminants of Pre/Post Trial #2, as measured over the early post-partum period of Example Two.

In Table 17, means of daily milk production, daily 4% fat-corrected milk production, and fat concentration in produced milk for multiparous cows derived from the raw data of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2,

and Control Trial #2 are provided. Again, the data means presented in Table 17 for Milk Production (As Is Basis) and for Milk Production (4% Fat Basis) were covariately adjusted using pre-trial milk production rates (weight basis) of the cows present during the trials detailed in Table 17.

TABLE 17

	Week(s)	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
Milk Production (As Is Basis - lbs/day)	+1	67.3	62.8	67.9	66.4	3.12				
	+2	94.3	92.6	93.8	92.8	2.90				
	+3	103	102	104	102	3.62				
	+4	108	111	109	108	3.95				
	+5	111	115	113	113	3.82				
	+6	113	115	113	113	3.72				

TABLE 17-continued

	Week(s)	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
Milk Production (4.0% fat basis - lbs/day)	+7	115	115	112	110	3.35				
	+8	114	111	114	108	3.94				
	+1 through +4	93.4	92.0	93.6	91.7	2.97				
	+5 through +8	113	115	113	111	3.57				
	+1 through +8	103	103	103	102	3.06				
	+1	79.4 ^{ab}	71.1 ^a	82.1 ^{ab}	88.6 ^b	4.80	0.08			
	+2	99	100	100	103	4.11				
	+3	105	104	107	106	4.49				
	+4	103	101	109	105	3.48				
	+5	99 ^a	104 ^{ab}	108 ^{ab}	111 ^b	4.18		0.08		
	+6	97	102	109	104	4.12		0.11		
	+7	100	102	103	101	3.66				
	+8	96.0 ^a	99.5 ^{ab}	108.7 ^b	94.4 ^a	4.36	0.09			0.02
Fat Content of Produced Milk (weight %)	+1 through +4	97.3	94.4	99.5	100.6	3.29				
	+5 through +8	98	102	107	102	3.43	0.15			
	+1 through +8	98	98	103	101	3.08				
	+1	5.32 ^{ab}	4.91 ^a	5.49 ^{ab}	6.23 ^b	0.340	0.05			0.12
	+2	4.39	4.50	4.41	4.73	0.212				
	+3	4.22	4.09	4.22	4.21	0.233				
	+4	3.77 ^{ab}	3.41 ^a	4.01 ^b	3.87 ^b	0.146	0.03		0.08	
	+5	3.43	3.35	3.71	3.89	0.194	0.18			
	+6	3.27 ^{ab}	3.17 ^a	3.69 ^b	3.48 ^{ab}	0.164	0.13			
	+7	3.13	3.29	3.45	3.47	0.157		0.12		
	+8	3.15 ^{ab}	3.34 ^{ab}	3.68 ^b	3.14 ^a	0.195	0.17			0.05
	+1 through +4	4.36 ^{ab}	4.23 ^a	4.53 ^{ab}	4.79 ^b	0.161	0.08			
	+5 through +8	3.19 ^a	3.27 ^{ab}	3.63 ^b	3.43 ^{ab}	0.134	0.10	0.09		
	+1 through +8	3.81 ^{ab}	3.75 ^a	4.09 ^{ab}	4.13 ^b	0.125	0.08	0.19		

P(01): Probability that means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2.

P(02): Probability that differences between the average of the three means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2.

P(03): Probability that differences between the means provided in row for Pre-Partum Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2.

P(04): Probability that differences between the means provided in row for Pre/Post Trial #1 versus the mean data provided in same row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

^{ab}For any row where a P(01) value appears and superscript letters are provided for the data of that row, data without any common superscript letter differ from each other at a probability P of <0.05

Data presented in Table 17 illustrates sorbitol feeding according to the present invention significantly increased the fat concentration in milk produced by the multiparous ruminants by 7.9% (P=0.09) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the fat concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over weeks +5 through +8 following the early post-partum period of Example Two. Furthermore, data presented in Table 17 illustrates sorbitol feeding according to the present invention significantly increased the fat concentration in milk produced by the multiparous ruminants by 4.7% (P=0.19) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the fat concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

Other data presented in Table 17 further illustrates sorbitol feeding according to the present invention increased production of 4% fat-corrected milk. For example, production of 4% fat-corrected milk by the multiparous ruminants of Pre/Post Trial #2 was 12.1% (P<0.05) greater than production of 4% fat-corrected milk by the multiparous ruminants of Control Trial #2 during week +5. Also, production of 4% fat-corrected milk by the multiparous ruminants of Pre/Post Trial #1 was 13.2% (P<0.05) greater than production of 4% fat-corrected milk by the multiparous ruminants of Control Trial #2 during week +8.

Data presented in Table 17 also indicates there are benefits to feeding sorbitol during both the pre-partum period and the early post-partum period, as opposed to only during the pre-partum period. For example, the fat concentration in milk

produced by the multiparous ruminants of Pre/Post Trial #2 was 13.24% (P<0.05) greater than the fat concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured over the entire early post-partum period (week +1 through week +4). Also, the fat concentration in milk produced by the multiparous ruminants of Pre/Post Trial #2 was 10.1% (P<0.05) greater than the fat concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured from the beginning of the early post-partum period through week+8 following the early post-partum period of Example Two. Furthermore, the rate of 4% fat-corrected milk production by the multiparous ruminants of Pre/Post Trial #2 was 24.6% (P<0.05) greater than the rate of 4% fat-corrected milk production by the multiparous ruminants of Pre-Partum Trial #2, as measured during week +1 of the early post-partum period.

Finally, data in Table 17 indicates that feeding sorbitol at a higher rate during the early post-partum period, in addition to feeding sorbitol during the pre-partum period, has beneficial effects. For example, the rate of 4% fat-corrected milk production by the multiparous ruminants of Pre/Post Trial #1 was 15.1% (P=0.02) greater than the rate of 4% fat-corrected milk production by the multiparous ruminants of Pre/Post Trial #2, as measured during week +8. Also, the fat concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 was 17.2% (P<0.05) greater than the fat concentration in milk produced by the multiparous ruminants of Pre/Post Trial #2, as measured during week +8.

In Table 18, means of the true protein concentration in milk produced by the multiparous cows derived from the raw data of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and Control Trial #2 are provided.

TABLE 18

	Week(s)	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
True Protein Content of Produced Milk (weight %)	+1	3.88	3.95	4.01	3.96	0.143				
	+2	3.15	3.14	3.17	3.13	0.0630				
	+3	2.77	2.81	2.85	2.89	0.0509		0.16		
	+4	2.65 ^a	2.71 ^{ab}	2.73 ^{ab}	2.77 ^b	0.0426		0.07		
	+5	2.63	2.63	2.65	2.70	0.0414				
	+6	2.59	2.62	2.61	2.69	0.0450				
	+7	2.58	2.60	2.57	2.64	0.0423				
	+8	2.60	2.56	2.65	2.61	0.0391				
	+1 through +4	3.04	3.11	3.18	3.18	0.0557		0.07		
	+5 through +8	2.60	2.60	2.62	2.66	0.0370				
	+1 through +8	2.82	2.86	2.90	2.91	0.0428		0.13		

P(01): Probability that means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2.

P(02): Probability that differences between the average of the three means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2.

P(03): Probability that differences between the means provided in row for Pre-Partum Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2.

P(04): Probability that differences between the means provided in row for Pre/Post Trial #1 versus the mean data provided in same row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

^{a,b}For any row where a P(01) value appears and superscript letters are provided for the data of that row, data without any common superscript letter differ from each other at a probability P of <0.05

Data presented in Table 18 illustrates sorbitol feeding according to the present invention significantly increased the true protein concentration in milk produced by the multiparous ruminants by 3.8% (P=0.07) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the true protein concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Furthermore, sorbitol feeding according to the present invention significantly increased the true protein concentration in milk produced by the multiparous ruminants by 2.5% (P=0.13) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the true protein concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

In Table 19, means of the lactose concentration in milk produced by the multiparous cows derived from the raw data of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and Control Trial #2 are provided.

Data presented in Table 19 illustrates sorbitol feeding according to the present invention significantly increased the lactose concentration in milk produced by the multiparous ruminants by 1.7% (P=0.19) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the lactose concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Additionally, sorbitol feeding according to the present invention significantly increased the lactose concentration in milk produced by the multiparous ruminants by 1.6% (P=0.12) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the lactose concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

Data presented in Table 19 also indicates there are benefits to feeding sorbitol during both the pre-partum period and the early post-partum period, as opposed to only during the pre-partum period. For example, the lactose concentration in milk produced by the multiparous ruminants of Pre/Post Trial #2

TABLE 19

	Week(s)	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
Lactose Content of Produced Milk (weight %)	+1	4.39	4.42	4.55	4.47	0.0862				
	+2	4.70 ^a	4.69 ^a	4.79 ^{ab}	4.84 ^b	0.0492	0.11	0.18		
	+3	4.77 ^{ab}	4.74 ^a	4.87 ^{ab}	4.92 ^b	0.0515	0.07			
	+4	4.74 ^a	4.75 ^a	4.90 ^b	4.90 ^b	0.0518	0.04	0.07		
	+5	4.78 ^{ab}	4.74 ^a	4.93 ^c	4.90 ^{bc}	0.0492	0.03			
	+6	4.75 ^a	4.75 ^a	4.90 ^{ab}	4.92 ^b	0.0538	0.04	0.09		
	+7	4.78 ^a	4.77 ^a	4.90 ^{ab}	4.96 ^b	0.0504	0.02	0.10		
	+8	4.76 ^a	4.76 ^a	4.84 ^{ab}	4.93 ^b	0.0462	0.03	0.09		0.18
	+1 through +4	4.66	4.65	4.78	4.78	0.0494	0.13	0.19		
	+5 through +8	4.77 ^a	4.76 ^a	4.89 ^{ab}	3.93 ^b	0.0468	0.03	0.10		
	+1 through +8	4.72 ^a	4.71 ^a	4.83 ^{ab}	4.85 ^b	0.0461	0.05	0.12		

P(01): Probability that means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2.

P(02): Probability that differences between the average of the three means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2.

P(03): Probability that differences between the means provided in row for Pre-Partum Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2.

P(04): Probability that differences between the means provided in row for Pre/Post Trial #1 versus the mean data provided in same row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

^{a,b}For any row where a P(01) value appears and superscript letters are provided for the data of that row, data without any common superscript letter differ from each other at a probability P of <0.05

35

was 3.0% ($P<0.05$) greater than the lactose concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured from the beginning of 0.15 the early post-partum period through week +8 following the early post-partum period of Example Two.

In Table 20, means of the total solids concentration in milk produced by the multiparous cows derived from the raw data of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and Control Trial #2 are provided.

TABLE 20

	Week(s)	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
Total Solids Content of Produced Milk (weight %)	+1	14.9 ^{ab}	14.4 ^a	15.3 ^{ab}	15.6 ^b	0.371	0.13			
	+2	13.15	13.25	12.28	13.61	0.235				
	+3	12.66	12.54	12.84	12.92	0.259				
	+4	11.95 ^{ab}	11.76 ^a	12.54 ^c	12.43 ^{bc}	0.186	0.01	0.17		
	+5	11.73	11.60 ^a	12.17 ^{ab}	12.38 ^b	0.200	0.02	0.16		
	+6	11.41 ^a	11.43 ^a	12.08 ^b	11.89 ^{ab}	0.197	0.05	0.09		
	+7	11.29	11.55	11.71	11.64	0.196		0.12		
	+8	11.23 ^a	11.45 ^{ab}	12.06 ^b	11.57 ^{ab}	0.230	0.08	0.08		0.14
	+1 through +4	13.00 ^a	12.94 ^a	13.49 ^{ab}	13.63 ^b	0.203	0.04	0.13		
	+5 through +8	11.42 ^a	11.51 ^a	12.02 ^b	11.87 ^{ab}	0.169	0.04	0.05		
	+1 through +8	12.20 ^a	12.23 ^a	12.76 ^b	12.73 ^b	0.177	0.03	0.06		

P(01): Probability that means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2.

P(02): Probability that differences between the average of the three means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2.

P(03): Probability that differences between the means provided in row for Pre-Partum Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2.

P(04): Probability that differences between the means provided in row for Pre/Post Trial #1 versus the mean data provided in same row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

^{a,b}For any row where a P(01) value appears and superscript letters are provided for the data of that row, data without any common superscript letter differ from each other at a probability P of <0.05 .

Data presented in Table 20 illustrates sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by the multiparous ruminants by 2.7% ($P=0.13$) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Additionally, sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by the multiparous ruminants by 3.3% ($P=0.05$) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from week +5 through week +8 of Example Two. Furthermore, sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by the multiparous ruminants by 1.1% ($P=0.06$) (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) versus the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

Other data presented in Table 20 further illustrates that sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by multiparous ruminants. For example, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #2 was 4.8% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Additionally, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 was 5.2% ($P<0.05$) greater than the total solids concentration in milk

36

produced by the multiparous ruminants of Control Trial #2, as measured from week +5 through week +8 of Example Two. Furthermore, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 was 4.6% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two. Finally, the total solids concentration in milk produced by the multiparous

ruminants of Pre/Post Trial #2 was 4.3% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

Data presented in Table 20 also indicates there are benefits to feeding sorbitol during both the pre-partum period and the early post-partum period, as opposed to only during the pre-partum period. For example, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #2 was 5.3% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured over the entire early post-partum period of Example Two. Additionally, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 was 4.4% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured from week +5 through week +8 of Example Two. Furthermore, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 was 4.3% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two. Finally, the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #2 was 4.1% ($P<0.05$) greater than the total solids concentration in milk produced by the multiparous ruminants of Pre-Partum Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

In Table 21, means derived from the raw data for the non-esterified fatty acid (NEFA) concentration in the blood of the multiparous cows participating in Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and Control Trial #2 are

provided at various points during the pre-partum period and the early post-partum period and proximate the junction of the pre-partum period and the early post-partum period.

TABLE 21

	Day	Target*	Control Trial #2	Pre-Partum Trial #2	Pre/Post Trial #1	Pre/Post Trial #2	SEM	P(01)	P(02)	P(03)	P(04)
Non-Esterified Fatty Acid (NEFA)	-21	<0.3	0.099	0.103	0.141	0.114	0.0282				
	-7	<0.35	0.133	0.122	0.107	0.119	0.277				
Concentration in Blood (mEq/l)	0 (Calving)	<1.0	0.705 ^b	0.470 ^{a,b}	0.416 ^a	0.637 ^{a,b}	0.951	0.12	0.07	0.08	0.11
	+10	<0.7	0.477	0.372	0.476	0.556	0.0671				

P(01): Probability that means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, Pre/Post Trial #2, and/or Control Trial #2.

P(02): Probability that differences between the average of the three means provided in row for Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol(s) of Pre-Partum Trial #2, Pre/Post Trial #1, and/or Pre/Post Trial #2 versus the feeding protocol of Control Trial #2.

P(03): Probability that differences between the means provided in row for Pre-Partum Trial #2 versus the mean data provided in same row for Control Trial #2 may be explained solely by the difference between the feeding protocol of Pre-Partum Trial #2 versus the feeding protocol of Control Trial #2.

P(04): Probability that differences between the means provided in row for Pre/Post Trial #1 versus the mean data provided in same row for Pre/Post Trial #2 may be explained solely by the difference between the feeding protocol of Pre/Post Trial #1 versus the feeding protocol of Pre/Post Trial #2.

^{a,b}For any row where a P(01) value appears and superscript letters are provided for the data of that row, data without any common superscript letter differ from each other at a probability P of <0.05.

*The Target blood concentrations for non-esterified fatty acid (NEFA) are recommended in Herdt, T. H.; Dart, B.; Neuder, L.; *Will Large Dairy Herds Lead to the Revival of Metabolic Profile Testing*, vol. 34, Proceedings of the American Association of Bovine Practitioners (AABP) from the 34th Annual Conference of the AABP (September, 2001, Vancouver, BC, Canada)

Data presented in Table 21 suggests that feeding sorbitol in accordance with the present invention substantially and significantly improves the energy balance of multiparous ruminants proximate the time the multiparous ruminants give birth. This helps explain why feeding sorbitol in accordance with the present invention produces other beneficial effects, such as increased fat-corrected milk production and increased milk component concentrations, and increased dry matter feed intake after the multiparous ruminants give birth. Indeed, as shown in Table 21, the concentrations of non-esterified fatty acid (NEFA) in blood for all three of the sorbitol feeding trials in accordance with the present invention are lower than the NEFA concentrations in blood found during Control Trial #2 and are well below the target NEFA concentrations in blood recommended in the Herdt et. al. document, both the week before calving and at calving.

The NEFA concentration in blood is a sensitive indicator of the energy balance for a particular ruminant. Higher NEFA concentrations in blood are a good indicator the ruminant being tested is in a negative energy balance condition and is excessively mobilizing stored energy resources; conversely, lower NEFA concentrations in blood are a good indicator the ruminant being tested is in a positive energy balance condition and has an adequate reserve of stored energy resources. Particularly soon before calving and proximate calving, it is desirable for ruminants to be in a positive energy balance condition that will tend to assure the ruminant recovers quickly from the stress of calving and thereby increases intake of feed and production of milk rapidly following calving.

With regard to the data provided in Table 21, the concentration of non-esterified fatty acid (NEFA) in the blood of the multiparous ruminants of Pre/Post Trial #2 was 42% lower (P<0.05) than the concentration of non-esterified fatty acid (NEFA) in the blood of the multiparous ruminants of Control Trial #2, as measured at about the time the various multiparous ruminants gave birth. Additionally, the concentration of non-esterified fatty acid (NEFA) in the blood of the multiparous ruminants fed sorbitol in accordance with the present invention (average of means of Pre-Partum Trial #2, Pre/Post Trial #1, and Pre/Post Trial #2) was collectively 28% lower (P<0.05) than the concentration of non-esterified fatty acid (NEFA) in the blood of the multiparous ruminants of Control Trial #2, as measured at about the time the various multiparous ruminants gave birth.

The means provided in Tables 22-27 are based solely on multiparous cows that were included in Pre/Post Trial #1 or Control Trial #2. In Table 22, means of dry matter feed intake

data derived from the raw data of the multiparous cows participating in the Pre/Post Trial #1 and Control Trial #2 are provided.

TABLE 22

		Week(s)	Control Trial #2	Pre/Post Trial #1	SEM	P
Dry Matter Feed Intake (lbs/day)	Pre-partum	-3	32.6	30.7	1.12	
		-2	36.7	35.2	1.12	
		-1	34.5	33.4	1.40	
		-3 through -1	34.6	33.0	0.891	
	Post-partum	+1	34.7	36.7	1.30	
		+2	42.8	45.6	1.55	
		+3	45.9	48.8	1.57	
		+4	49.6	51.5	1.61	
		+5	51.5	54.2	1.34	
		+6	53.0	54.1	1.39	
		+7	54.0	54.9	1.39	
		+8	54.6	57.4	1.87	
		+1 through +4	43.2	45.7	1.33	
		+5 through +8	53.3	55.3	1.37	
		+1 through +8	48.3	50.4	1.22	
Change in Dry Matter Feed Intake (lbs/day)		-2 versus -1	-2.22	-1.83	1.19	
		+1 versus -1	0.16	3.35	1.26	0.09

The data of Table 22 shows the multiparous ruminants of Pre/Post Trial #1 increased dry matter feed intake by a numeric amount that was 3.19 pounds per day greater, or nearly twenty times larger (P=0.09), as compared to the multiparous ruminants of Control Trial #2, when looking at the week (-1) before calving versus the week (+1) after calving. This substantial and significant dry matter feed intake recovery and increase reflects the beneficially high energy balance of the multiparous ruminants of Pre/Post Trial #1 that is directly attributable to sorbitol feeding in accordance with the present invention. FIG. 4 is a plot of the daily dry matter feed intake weights for the multiparous cows of Pre/Post Trial #1 versus the multiparous cows of Control Trial #2, by week extending from the beginning of the pre-partum period (weeks -3 through -1), through the early post-partum period (weeks +1 through +4), and through week +8.

In Table 23, means of daily milk production rates, daily 4% fat-corrected milk production rates, and fat concentration in produced milk derived from the raw data of the multiparous cows participating in the Pre/Post Trial #1 and Control Trial #2 are provided.

39

TABLE 23

	Week(s)	Control Trial #2	Pre/Post Trial #1	SEM	P
Milk Production (As Is Basis - lbs/day)	+1	67.4	68.4	2.99	
	+2	94.9	93.9	2.94	
	+3	104	104	3.82	
	+4	109	109	4.26	
	+5	11	113	4.26	
	+6	114	113	4.02	
	+7	115	112	3.36	
	+8	113	115	4.17	
	+1 through +4	93.8	94.1	3.15	
	+5 through +8	113	113	3.76	
	+1 through +8	104	104	3.26	
Milk Production (4.0% fat basis - lbs/day)	+1	79.8	82.4	4.57	
	+2	100.1	99.7	4.00	
	+3	107	107	3.98	
	+4	104	109	3.89	
	+5	100	108	4.10	0.19
	+6	98	109	4.03	0.08
	+7	101	103	4.23	
	+8	96	109	5.20	0.10
	+1 through +4	98.3	99.7	3.25	
	+5 through +8	99	107	3.62	0.13
Fat Content of Produced Milk (weight %)	+1 through +8	99	103	3.13	
	+1	5.32	5.49	0.363	
	+2	4.39	4.41	0.202	
	+3	4.22	4.22	0.208	
	+4	3.77	4.01	0.155	
	+5	3.43	3.71	0.164	
	+6	3.27	3.69	0.161	0.07
	+7	3.13	3.45	0.174	
	+8	3.15	3.68	0.227	0.11
	+1 through +4	4.36	4.53	0.163	
	+5 through +8	3.19a	3.63	0.130	0.02
	+1 through +8	3.81	4.09	0.127	0.12

Data presented in Table 23 illustrates sorbitol feeding according to the present invention significantly increased the fat concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by 13.8% (P=0.02) versus the fat concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over weeks +5 through +8 following the early post-partum period of Example Two. Furthermore, data presented in Table 23 illustrates sorbitol feeding according to the present invention significantly increased the fat concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by 7.3% (P=0.12) versus the fat concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

Additionally, data presented in Table 23 illustrates sorbitol feeding according to the present invention increased production of 4% fat-corrected milk by the multiparous ruminants of Pre/Post Trial #1 8.1% (P=0.13), as compared to the multiparous ruminants of Control Trial #2 over weeks +5 through +8 following the early post-partum period of Example Two. FIG. 5 is a plot of the daily weight production of 4% fat corrected milk for the multiparous cows of Pre/Post Trial #1 versus the multiparous cows of Control Trial #2, by week extending from the beginning of the early post-partum period (weeks +1 through +4) through week +8.

In Table 24, means of true protein concentration in produced milk derived from the raw data of the multiparous cows participating in the Pre/Post Trial #1 and Control Trial #2 are provided.

40

TABLE 24

	Week(s)	Control Trial #2	Pre/Post Trial #1	SEM	P
True Protein Content of Produced Milk (weight %)	+1	3.88	4.01	0.149	
	+2	3.15	3.17	0.0588	
	+3	2.77	2.85	0.0468	
	+4	2.65	2.73	0.0413	0.17
	+5	2.63	2.65	0.0434	
	+6	2.59	2.61	0.0367	
	+7	2.58	2.57	0.0404	
	+8	2.60	2.65	0.0417	
	+1 through +4	3.04	3.18		0.08
	+5 through +8	2.60	2.62		
	+1 through +8	2.82	2.90		0.16

Data presented in Table 24 illustrates sorbitol feeding according to the present invention significantly increased the true protein concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by 4.6% (P=0.08) versus the true protein concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Furthermore, data presented in Table 24 illustrates sorbitol feeding according to the present invention significantly increased the true protein concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by 2.8% (P=0.16) versus the true protein concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

In Table 25, means of lactose concentration in produced milk derived from the raw data of the multiparous cows participating in the Pre/Post Trial #1 and Control Trial #2 are provided.

TABLE 25

	Week(s)	Control Trial #2	Pre/Post Trial #1	SEM	P
Lactose Content of Produced Milk (weight %)	+1	4.39	4.55	0.0836	0.17
	+2	4.70	4.79	0.0513	
	+3	4.77	4.87	0.0575	
	+4	4.74	4.90	0.0555	0.05
	+5	4.78	4.93	0.0524	0.07
	+6	4.75	4.90	0.0563	0.08
	+7	4.78	4.90	0.0511	0.11
	+8	4.76	4.84	0.0481	
	+1 through +4	4.66	4.78		0.13
	+5 through +8	4.77	4.89		0.09
	+1 through +8	4.72	4.83		0.10

Data presented in Table 25 illustrates sorbitol feeding according to the present invention significantly increased the lactose concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by more than 2.5% (P=0.13) versus the lactose concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Additionally, sorbitol feeding according to the present invention significantly increased the lactose concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by more than 2.5% (P=0.09) versus the lactose concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over weeks +5 through +8 following the early post-partum period of Example Two. Furthermore, data presented in Table 25 illustrates sorbitol feeding according to the present invention significantly increased the lactose concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by 1.9% (P=0.10) versus the lactose con-

41

centration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

In Table 26, means of total solids concentration in produced milk derived from the raw data of the multiparous cows participating in the Pre/Post Trial #1 and Control Trial #2 are provided.

TABLE 26

	Week(s)	Control Trial #2	Pre/Post Trial #1	SEM	P
Total Solids Content	+1	14.9	15.3	0.383	
of Produced Milk	+2	13.15	13.28	0.224	
(weight %)	+3	12.66	12.84	0.228	
	+4	11.95	12.54	0.185	0.03
	+5	11.73	12.17	0.170	0.07
	+6	11.41	12.08	0.179	0.01
	+7	11.29	11.71	0.194	0.13
	+8	11.23	12.06	0.253	0.03
	+1 through +4	13.00	13.49	0.204	0.10
	+5 through +8	11.42	12.02	0.162	0.01
	+1 through +8	12.20	12.76	0.172	0.03

Data presented in Table 26 suggests sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by more than 3.7% (P=0.19) versus the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over the entire early post-partum period of Example Two. Additionally, sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by more than 5.2% (P=0.01) versus the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured over weeks +5 through +8 following the early post-partum period of Example Two. Furthermore, data presented in Table 26 illustrates sorbitol feeding according to the present invention significantly increased the total solids concentration in milk produced by the multiparous ruminants of Pre/Post Trial #1 by nearly 4.6% (P=0.03) versus the total solids concentration in milk produced by the multiparous ruminants of Control Trial #2, as measured from the beginning of the early post-partum period through week +8 of Example Two.

In Table 27, means of the concentration of non-esterified fatty acid in the blood of multiparous cows that is derived from the raw data of the multiparous cows participating in the Pre/Post Trial #1 and Control Trial #2 are provided.

TABLE 27

	Day	Target*	Control Trial #2	Pre/Post Trial #1	SEM	P
Non-Esterified Fatty Acid (NEFA)	-21	<0.3	0.099	0.141	0.0368	
	-7	<0.35	0.133	0.107	0.0342	
Concentration in Blood (mEq/l)	0 (Calving)	<1.0	0.705 ^b	0.416 ^b	0.0928	0.04
	+10	0.7	0.477	0.476	0.0632	

*The Target blood concentrations for non-esterified fatty acid (NEFA) are recommended in Herdt, T. H.; Dart, B.; Neuder, L.; *Will Large Dairy Herds Lead to the Revival of Metabolic Profile Testing*; vol. 34, Proceedings of the American Association of Bovine Practitioners (AABP) from the 34th Annual Conference of the AABP (September, 2001, Vancouver, BC, Canada)

Data presented in Table 27 illustrates that feeding sorbitol in accordance with the present invention substantially and significantly improves the energy balance of multiparous ruminants at the time the multiparous ruminants give birth. This helps explain why feeding sorbitol in accordance with the present invention produces other beneficial effects, such

42

as increased fat-corrected milk production and increased milk component concentrations, and increased dry matter feed intake after the multiparous ruminants give birth. Indeed, as shown in Table 27, the concentrations of non-esterified fatty acid (NEFA) in blood for Pre/Post Trial #1 are significantly lower {42% lower (P=0.04)} than the NEFA concentrations in blood found during Control Trial #2 and are well below the target NEFA concentrations in blood recommended in the Herdt et. al. document at calving. FIG. 6 is a plot of NEFA concentrations in blood for the multiparous cows of Pre/Post Trial #1 versus the multiparous cows of Control Trial #2 twenty days prior to calving (day -21), seven days prior to calving (day -7), and at calving (day 0).

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

The invention claimed is:

1. A method of feeding a ruminant, the method comprising: providing a feed that comprises sugar alcohol and at least one additional feed component, the sugar alcohol fully digestible in the rumen of the ruminant, the feed free of glycerol; and

orally supplying the feed to the ruminant during a pre-partum period when the ruminant is pregnant, the ruminant ingesting the feed with the sugar alcohol during the pre-partum period at least when the pregnant ruminant is not lactating;

wherein ingesting the sugar alcohol in the feed during the pre-partum period causes the ruminant to increase milk component concentration during milk production after the ruminant gives birth.

2. The method of claim 1, wherein the increased milk component concentration comprises one or more of increased total fat concentration, increased protein concentration, increased lactose concentration or increased total solids concentration.

3. The method of claim 1, wherein the increased milk component concentration comprises increased protein concentration, and wherein the protein concentration comprises a measure of one or more of total protein or true protein.

4. The method of claim 1, wherein the pregnant ruminant ingests about 50 grams of the sugar alcohol per day when the pregnant ruminant is not lactating.

5. The method of claim 1, wherein the pregnant ruminant ingests as much as about 200 grams of the sugar alcohol per day when the pregnant ruminant is not lactating.

6. The method of claim 1, wherein the pre-partum period starts about eight weeks before the ruminant gives birth.

7. The method of claim 1, wherein the pre-partum period starts about three weeks before the ruminant gives birth.

8. The method of claim 1, wherein the sugar alcohol comprises sorbitol, adonitol, allitol, altritol, arabinitol, dulcitol,

erythritol, galaxitol, glucitol, iditol, inositol, isomalt, lactitol, maltitol, mannitol, perseitol, ribitol, rhamnitol, threitol, or xylitol, or any of these in any combination.

9. A method of feeding a ruminant, the method comprising:
 providing a feed that comprises sorbitol and at least one
 additional feed component, the feed free of glycerol and
 the sorbitol fully digestible in the rumen of the ruminant;
 and
 orally supplying the feed to the ruminant during a pre-
 partum period when the ruminant is pregnant, the rumi-
 nant ingesting the feed with the sorbitol during the pre-
 partum period at least when the pregnant ruminant is not
 lactating;
 wherein ingesting the sorbitol in the feed during the pre-
 partum period causes the ruminant to increase milk com-
 ponent concentration during milk production after the
 ruminant gives birth.

10. The method of claim 9, wherein the increased milk
 component concentration comprises one or more of increased
 total fat concentration, increased protein concentration,
 increased lactose concentration or increased total solids con-
 centration.

11. The method of claim 9, wherein the increased milk
 component concentration comprises increased protein con-
 centration, and wherein the protein concentration comprises a
 measure of one or more of total protein or true protein.

12. The method of claim 9, wherein the pregnant ruminant
 ingests about 50 grams of the sorbitol per day when the
 pregnant ruminant is not lactating.

13. The method of claim 9, wherein the pregnant ruminant
 ingests as much as about 200 grams of the sorbitol per day
 when the pregnant ruminant is not lactating.

14. The method of claim 9, wherein the pre-partum period
 starts about eight weeks before the ruminant gives birth.

15. The method of claim 9, wherein the pre-partum period
 starts about three weeks before the ruminant gives birth.

16. A method of feeding a ruminant, the method compris-
 ing:

providing a feed that comprises sugar alcohol and at least
 one additional feed component, the sugar alcohol fully
 digestible in the rumen of the ruminant and comprising
 sorbitol, adonitol, allitol, altritol, arabinitol, dulcitol,
 erythritol, galaxitol, glucitol, iditol, inositol, isomalt,
 lactitol, maltitol, mannitol, perseitol, ribitol, rhamnitol,
 threitol, or xylitol, or any of these in any combination;
 and

orally supplying the feed to the ruminant during a pre-
 partum period, the ruminant ingesting the feed with the
 sugar alcohol during the pre-partum period at least when
 the pregnant ruminant is not lactating;

wherein ingesting the sugar alcohol in the feed during the
 pre-partum period causes the ruminant to increase milk
 component concentration during milk production after
 the ruminant gives birth.

17. The method of claim 16, wherein the increased milk
 component concentration comprises one or more of increased
 total fat concentration, increased protein concentration,
 increased lactose concentration or increased total solids con-
 centration.

18. The method of claim 16, wherein the increased milk
 component concentration comprises increased protein con-
 centration, and wherein the protein concentration comprises a
 measure of one or more of total protein or true protein.

19. The method of claim 16, wherein the pregnant ruminant
 ingests as little as about 50 grams of the sugar alcohol per day
 when the pregnant ruminant is not lactating.

20. The method of claim 16, wherein the pregnant ruminant
 ingests as much as about 200 grams of the sugar alcohol per
 day when the pregnant ruminant is not lactating.

21. The method of claim 16, wherein the pre-partum period
 starts about eight weeks before the ruminant gives birth.

22. The method of claim 16, wherein the pre-partum period
 starts about three weeks before the ruminant gives birth.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,179,694 B2
APPLICATION NO. : 14/060758
DATED : November 10, 2015
INVENTOR(S) : Porter et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

SPECIFICATION

<u>Column</u>	<u>Line</u>		<u>Should Be</u>
13	7-8	“female ruminants) by at least”	-- female ruminant(s) by at least --
17	57	“from week +0.5 through week +8”	-- from week +5 through week +8 --
20	60	“the second postpartum control”	-- the second post-partum control --
21	15	“*Based on Total Dry Matter Weigh of Second”	-- *Based on Total Dry Matter Weight of Second --
21	40	“FRESH IRAN PLUS® formula feed,”	-- FRESH TRAN PLUS® formula feed, --
22	44	“with about 100 gams of”	-- with about 100 grams of --
28	53	“and (0 Pre/Post Trial #1 vs.”	-- and (f) Pre/Post Trial #1 vs. --
35	3	“beginning of 0.15 the early”	-- beginning of the early --
41	56	“0.416 ^b ” <i>[Table 27; 3rd row under column Pre/Post Trial #1]</i>	-- 0.416 ^a --
41	57	“0.7” <i>[Table 27; 4th row under column Target*]</i>	-- <0.7 --

CLAIMS

<u>Column</u>	<u>Line</u>	<u>Claim</u>	<u>Line</u>		<u>Should Be</u>
44	27	19	2	“ingests as little as about 50 grams”	-- ingests about 50 grams --

Signed and Sealed this
Eighth Day of March, 2016



Michelle K. Lee
Director of the United States Patent and Trademark Office